Mahatma Gandhi University, Kottayam

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B.Sc Chemistry (CBCSS) Syllabus

Prepared by

Board of Studies (UG) in Chemistry

&

Faculty of Science

May 2017

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ACKNOWLEDGEMENTS

I am grateful to all of those with whom I have had the pleasure to work during the restructuring of the syllabus and curriculum of **B.Sc Chemistry (CBCSS) Programme 2017** of Mahatma Gandhi University. There are many personalities whose support and guidance made this restructured syllabus a reality.

I express my profound gratitude to the Honorable Vice Chancellor, Pro-Vice Chancellor, Registrar, Members of the Syndicate and the Academic Council for their leadership and guidance for making this endeavor a great success. Each of the members of the Faculty of Science, and Board of Studies (UG) in Chemistry of Mahatma Gandhi University has provided me extensive personal and professional support during the work of restructuring this syllabus. I place on record my wholehearted gratitude to all the members of the **Faculty of Science** and **BOS (UG) in Chemistry**. I would like to thank the staff of Mahatma Gandhi University, the Academic Section in particular, for their help and support. With immense pleasure and gratitude I remember the untiring support rendered by the faculty members of Chemistry from various Colleges of Mahatma Gandhi University who worked hard in preparing this restructured syllabus and curriculum for the UG students of Mahatma Gandhi University. I also place on record the help and support given by the academic community and all other stake holders.

Dean, Faculty of Science

Mahatma Gandhi University

Priyadarsini Hills

May 03, 2017

1. INTRODUCTION

Mahatma Gandhi University introduced choice based credit and semester and Grading System in colleges affiliated to the University from the Academic year 2009- 2010, under **Direct Grading System**. Subsequently, the Kerala State Higher Education Council constituted a committee of experts headed by Prof. B. Hridayakumari, to study and make recommendations for the improvement of the working of the Choice Based Credit and Semester System in Colleges affiliated to the Universities in the State. The State Government accepted the recommendations of the Committee and the Syndicate and the Academic Council of the Mahatma Gandhi University have resolved to reform the existing CBCSS regulations. Accordingly, REGULATIONS FOR UNDER GRADUATE PROGRAMMES UNDER CHOICE BASED COURSE-CREDIT-SEMESTER SYSTEM AND GRADING, 2013 was introduced in the University from the Academic year 2013-14 onwards, under **Indirect Grading System.** The University Grants Commission, in order to facilitate student mobility across institutions within and across countries and also to enable potential employers to assess the performance of students, insisted to introduce uniform grading system in the Universities. The Academic Council of the Mahatma Gandhi University at its meeting held on 23rd May 2015 resolved to introduce the UGC Guidelines for Choice Based Credit Semester System from the Academic year 2016-17 onwards and the syndicate of the University at its meeting held on 1st August 2015 approved the resolution of the Academic Council. Meanwhile, the Hon'ble Supreme Court of India has issued orders to include core courses on Environmental Studies and Human Rights in the syllabi and curricula of all UG Progammes of universities all over India. In continuation to this the University Grants Commission has issued circulars regarding the implementation of the above said changes by accepting the directions of the Hon'ble Supreme Court as a National Policy. Hence, the Syndicate of Mahatma Gandhi University has decided to modify the syllabi and curricula of all UG programmes in accordance with the directions of the Hon'ble Supreme Court and the UGC. Further, the Syndicate has decided to implement the new regulations and syllabi with effect from the academic year 2017-2018. In view of this, the BOS – Chemistry (UG) and the Faculty of Science of MG University have prepared the following syllabus for UG programmes in Chemistry.

2. TITLE

B.Sc CHEMISTRY PROGRAMME - Graduate Programmes under Choice Based Credit System, **2017**" (UGCBCSS 2017).

3. SCOPE

3.1 Applicable to all regular Under Graduate Programmes conducted by the University with effect from 2017 admissions, except for Professional and B.Voc programmes. Also applicable to Distance/Private Undergraduate Programmes with suitable modifications. Under Graduate Programmes in Management Studies are included as non-professional programmes. Provided that the existing CBCSS Regulations 2013 shall be applicable to students who were admitted prior to the commencement of these Regulations and who are continuing their studies.

3.2 Examinations of the courses being run under the Distance/Private registration scheme shall be conducted annually.

3.3 The provisions herein supersede all the existing regulations for the Regular/Distance/Private Undergraduate programmes to the extent herein prescribed.

4. AIMS AND OBJECTIVES OF THE PROGRAMME

4.1 AIMS

The Facuty of Science, Mahatma Gandhi University and Board of Studies in Chemistry (UG) recognizes that curriculum, course content and assessment of scholastic achievement play complementary roles in shaping education. The committee is of the view that assessment should support and encourage the broad instructional goals such as basic knowledge of the discipline of Chemistry including theories and techniques, concepts and general principles. This should also support the ability to ask physical questions and to obtain solutions to physical questions by use of qualitative and quantitative reasoning and by experimental investigation. The important student attributes including keen observation, curiosity, creativity and reasoned skepticism and understanding links of Chemistry to other disciplines and to societal issues should be given encouragement. With this in mind, we aim to provide a firm foundation in every aspect of Chemistry and to explain a broad spectrum of modern trends in chemistry and to develop experimental, computational and mathematics skills of students.

The programme also aims to develop the following abilities:

1. Read, understand and interpret chemical information – verbal, mathematical and graphical.
2. Impart skills required to gather information from resources and use them.
3. To give need based education in chemistry of the highest quality at the undergraduate level.
4. Offer courses to the choice of the students.
5. Perform experiments and interpret the results of observation.
6. Provide an intellectually stimulating environment to develop skills and enthusiasms of students to the best of their potential.
7. Use Information Communication Technology to gather knowledge at will.
8. Attract outstanding students from all backgrounds.

4.2 OBJECTIVES

The syllabi are framed in such a way that it bridges the gap between the plus two and post graduate levels of Chemistry by providing a more complete and logical framework in almost all areas of basic Chemistry.

5. COURSE DESIGN

The U.G.programme in Chemistry must include (a) Common courses, (b) Core courses, (c) Complementary Courses, (d) Choice based courses (e) open courses and (f) Project, Industrial Visit (I.V.) and Comprehensive viva - voce. No course shall carry more than 4 credits. The student shall select any one open course in Sem V offered by the Departments which offers the core courses or physical education department, depending on the availability of infrastructure facilities, in the institution. The number of Courses for the restructured programme should contain 12 compulsory core courses,1 open course,1 choice based course from the frontier area of the core courses, 6 core practicals,1 project & I.V. in the area of core,
8 complementary courses, 2 complementary practicals otherwise specified, from the relevant subjects for complementing the core of study. There should be 10 common courses, or otherwise specified, which includes the first and second language of study.

6. B.Sc PROGRAMME IN CHEMISTRY

6.1. PROGRAMME STRUCTURE

(i) MODEL I B.Sc CHEMISTRY

A	**Programme Duration**	**6 Semesters**
B	Total Credits required for successful completion of the Programme	120
C	Credits required from Common Course I	22
D	Credits required from Common Course II	16
E	Credits required from Core course and Complementary courses including Project	79
F	Open Course	3
G	Minimum attendance required	75%

(ii) MODEL II B.Sc CHEMISTRY

A	**Programme Duration**	**6 Semesters**
B	Total Credits required for successful completion of the Programme	120
C	Credits required from Common Course I	16
D	Credits required from Common Course II	8
E	Credits required from Core + Complementary + Vocational Courses including Project	93
F	Open Course	3
G	Minimum attendance required	75%

(iii) MODEL III B.Sc CHEMISTRY

A	**Programme Duration**	**6 Semesters**
B	Total Credits required for successful completion of the Programme	120
C	Credits required from Common Course I	8
D	Credits required from Core + Complementary + Vocational Courses including Project	109
e	Open Course	3
f	Minimum attendance required	75%

6.2. COURSES

There shall be three different types (models) of courses in Chemistry programme. The programme (Model I) consists of common courses with 38 credits, core course, Choice based course, and complementary courses with 79 credits and open course with 3 credits. The programme (Vocational -Model II) consists of common courses with 24 credits, core courses; Choice based courses, and complementary courses with 93 credits and open course with 3 credits. The programme (Model III) consists of common courses with 8 credits, core, Choice based course and complementary courses with 109 credits and open course with 3 credits.

6.3 SCHEME OF COURSES

The different types of courses and its number are as the following:

Model- I		**Model- II**		**Model- III**	
Courses	***No.***	***Courses***	***No.***	***Courses***	***No.***
Common Courses	10	Common Courses	6	Common Courses	2
Core Courses (Theory)	12	Core Courses (Theory)	12	Core Courses (Theory)	12
Project, Industrial Visit. and Comprehensive viva-voce	1	Project, Industrial Visit. and Comprehensive viva-voce	1	Project, Industrial Visit. and Comprehensive viva-voce	1
Core practical	6	Core Practical	6	First Core practical	6
Open Course	1	Open Course	1	Open Course	1
Choice based Course	1	Choice based Course	1	Choice based Course	1
		Vocational courses	6	Second core Courses	6
		Vocational practical	3	Second Core practical	2
		OJT	1	OJT	1
Complementary Courses	10	Complementary Courses	4	Complementary Courses	8
		Complementary practical	2	Complementary practical	2
Total	**41**	**Total**	**43**	**Total**	**42**

6.4. COURSE CODE

Every course in the programme should be coded with an eight digit alphanumeric code according to the following criteria. The first two letters of the code indicates the name of programme i.e. CH for Chemistry. One digit to indicate the semester. ie., CH1 (Chemistry, 1st semester). Two letters form the type of courses such as, CC for common courses, CR for core course, VO for vocational course, CM for Complementary courses, OP for Open Course,

CB for Choice based core, OJ for On the Job Training, OC for Optional Core, PR for project ie.., CH1CR (Chemistry,1st semester Core course). The letter T may be used to denote theory paper and the letter P may be used to denote practical papers. Two digits to indicate the paper's relative position in the programme, i.e., CH5CRT06 (Chemistry, 5th semester, Core course, Theory, sixth paper).

6.5. COURSES WITH CREDITS

Courses with Credits of different courses and scheme of examinations of the programme is the following:

Courses	**Credits**		
	Model I	**Model II**	**Model III**
Core Courses	46	46	46
Open Course	3	3	3
Choice Based Core	3	3	3
Project, I.V. & Viva	2	2	2
Vocational Courses	Nil	24	Nil
OJT	-	2	2
2nd Core Courses	Nil	Nil	24
Total	**54**	**80**	**80**
Complementary Courses I	14	16	16
Complementary Courses II	14	Nil	16
Total	**28**	**16**	**32**
Common Courses	38	24	8
Total	**38**	**24**	**8**
Grand Total	**120**	**120**	**120**

6.6. SCHEME OF DISTRIBUTION OF INSTRUCTIONAL HOURS FOR CORE COURSES

Semester	**Model I**		**Model II**		**Model III**	
	Theory	**Practical**	**Theory**	**Practical**	**Theory**	**Practical**
First	2	2	6	4	6	4
Second	2	2	6	4	6	4
Third	3	2	9	6	10	4
Fourth	3	2	9	6	10	4
Fifth	15	10	15	10	15	10
Sixth	15	10	15	10	15	10

7. DURATION OF COURSE

The duration of U.G. Programmes shall be **6 semesters**.

A student may be permitted to complete the programme, on valid reasons, within a period of 12 continuous semesters from the date of commencement of the first semester of the programme.

Attendance: Students having a minimum of 75% average attendance for all the courses only, can register for the examination.

8. MARKS DISTRIBUTION FOR EXTERNAL EXAMINATION AND INTERNAL EVALUATION

The external theory examination of all semesters shall be conducted by the University at the end of each semester. Internal evaluation is to be done by continuous assessment. For all papers (theory and practical) total percentage of marks of external examination is 80 and total percentage of marks of internal evaluation is 20.

Marks distribution for external and internal assessments and the components for internal evaluation with their marks are shown below:

Components of the internal evaluation and their marks are as below.

8. 1. FOR ALL THEORY PAPERS:

(a) Marks of external Examination : 60

(b) Marks of internal evaluation : 15

All the three components of the internal assessment are mandatory.

Components of theory Internal Evaluation	**MARKS**
Attendance	**5**
Assignment/Seminar/Viva	**2**
Test Paper(s) **(2×4)**	**8**
Total	**15**

8.2 FOR ALL PRACTICAL PAPERS (conducted only at the end of even semesters):

(a) Marks of external Examination : 40

(b) Marks of internal evaluation : 10

All the three components of the internal assessment are mandatory

Components of Practical-internal evaluation	**Marks**
Attendance	**2**
Test Paper (1x4)	**4**
Record*	**4**
Total	**10**

*Marks awarded for Record should be related to number of experiments recorded.

8.3 FOR PROJECTS, INDUSTRIAL VISIT AND COMPREHENSIVE VIVA-VOCE*:

(a) Marks of external Examination : 80

(b) Marks of internal evaluation : 20

Components of Project I.V. and Viva – Evaluation External	**Marks**
Dissertation and I.V. report (External)	50
Comprehensive Viva-voce (External)	30
Total	**80**

* Bonafide reports of the project work and Industrial Visit conducted shall be submitted at the time of examination.

All the four components of the internal assessment are mandatory.

Components of Project & I.V. - Internal Evaluation	Marks
Punctuality	5
Experimentation / Data Collection	5
Knowledge	5
Report	5
Total	**20**

Attendance Evaluation for all papers

% of attendance	Marks
90 and above	5
85–89	4
80-84	3
76-79	2
75	1

(Decimals are to be rounded to the next higher whole number)

8.4 OJT EVALUATION

For On the Job Training there is only internal evaluation.

8.5. ASSIGNMENTS

Assignments are to be done from 1st to 4th Semesters. At least one assignment should be done in each semester for all papers.

8.6 SEMINAR / VIVA

A student shall present a seminar in the 5^{th} semester and appear for Viva- voce in the 6^{th} semester for all papers.

8.7 INTERNAL ASSESSMENT TEST PAPERS

Two internal test- papers are to be attended in each semester for each paper. The evaluations of all components are to be published and are to be acknowledged by the candidates. All documents of internal assessments are to be kept in the college for two years and shall be made available for verification by the University. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teach the paper.

9. CONDUCT OF PRACTICAL EXAMINATIONS

9.1 **PRACTICAL EXAMINATION**

Practical examinations will be conducted only at the end of even semesters for all programmes.

9.2. **PATTERN OF QUESTION PAPERS**

Pattern of questions for external examination of practical papers will decided by the concerned Board of practical examination.

CONSOLIDATED SCHEME FOR I TO VI SEMESTERS
PROGRAMME STRUCTURE

1. B.Sc CHEMISTRY PROGRAMME – (MODEL - I)

Sem	Title with Course code	Course Category	Hours per week	Credits
I	English I	Common	5	4
	English/ Common Course I	Common	4	3
	Second Language I	Common	4	4
	CHICRT01 General and Analytical Chemistry	Core	2	2
	CH2CRP01 Volumetric Analysis	Core	2	-
	Complementary Mathematics	Complementary	4	3
	Complementary Physics	Complementary	2	2
	Complementary Physics Practical	Complementary	2	-
II	English II	Common	5	4
	English/ Common Course II	Common	4	3
	Second Language II	Common	4	4
	CH2CRT02 Theoretical and Inorganic Chemistry	Core	2	2
	CH2CRP01 Volumetric Analysis	Core	2	2
	Complementary Mathematics	Complementary	4	3
	Complementary Physics	Complementary	2	2
	Complementary Physics Practical	Complementary	2	2
III	English III	Common	5	4
	II Lang/Common Course I	Common	5	4
	CH3CRT03 Organic Chemistry-I	Core	3	3
	CH4CRP02 Qualitative Organic Analysis	Core	2	-
	Complementary Mathematics	Complementary	5	4
	Complementary Physics	Complementary	3	3
	Complementary Physics Practical	Complementary	2	-
IV	English IV	Common	5	4
	II Lang/ Common Course II	Common	5	4
	CH4CRT04 Organic Chemistry-II	Core	3	3
	CH4CRP02 Qualitative Organic Analysis	Core	2	2
	Complementary Mathematics	Complementary	5	4
	Complementary Physics	Complementary	3	3
	Complementary Physical Practical	Complementary	2	2
V	CH5CRT05 Environment, Ecology and Human Rights	Core	4	4
	CH5CRT06 Organic Chemistry-III	Core	3	3
	CH5CRT07 Physical Chemistry - I	Core	2	2
	CH5CRT08 Physical Chemistry - II	Core	2	3
	CH5OPT Open course	Open	4	3

	CH6CRP03 Qualitative Inorganic Analysis	Core	3	-
	CH6CRP04 Organic Preparations and Basic Laboratory Techniques	Core	2	-
	CH6CRP05 Physical Chemistry Practical	Core	3	-
	CH6PRP01Project	Core	2	-
VI	CH6CRT09 Inorganic Chemistry	Core	3	3
	CH6CRT10 Organic Chemistry-IV	Core	3	3
	CH6CRT11 Physical Chemistry - III	Core	3	3
	CH6CRT12 Physical Chemistry - IV	Core	3	3
	CH6CBT Choice Based Course	Core	3	3
	CH6CRP03 Qualitative Inorganic Analysis	Core	3	2
	CH6CRP04 Organic Preparations and Basic Laboratory Techniques	Core	2	2
	CH6CRP05 Physical Chemistry Practical	Core	3	2
	CH6CRP06 Gravimetric Analysis	Core	2	2
	CH6PRP01 Project & Industrial visit and comprehensive viva-voce	Core	-	2

OPEN COURSES:

Sl. No.	Semester	Course Code	Course Title
1	V	CH5OPT01	Chemistry in Everyday Life
2	V	CH5OPT02	Nanoscience and Nanotechnology
3	V	CH5OPT03	Forensic Science

CHOICE BASED COURSES:

Sl. No.	Semester	Course Code	Course Title
1	VI	CH6CBT01	Polymer Chemistry
2	VI	CH6CBT02	Nanochemistry and Nanotechnology
3	VI	CH6CBT03	Soil and Agricultural Chemistry

2. B.Sc CHEMISTRY PROGRAMME – (MODEL - II)

Sem	Title with Course code	Course Category	Hours per week	Credits
I	English I	Common	5	4
	Second Language I	Common	5	4
	CHICRT01 General and Analytical Chemistry	Core	2	2
	CH2CRP01 Volumetric Analysis	Core	2	-
	Complementary Mathematics	Complementary	5	3
	CH1VOT01 Industrial Aspects of Inorganic and Organic Chemistry	Core	4	3
	CH2VOP01 Vocational Practical	Core	2	-
II	English I	Common	5	4
	Second Language I	Common	5	4
	CH2CRT02 Theoretical and Inorganic Chemistry	Core	2	2
	CH2CRP01 Volumetric Analysis	Core	2	2
	Complementary Mathematics	Complementary	5	3
	CH2VOT02 Chemical Industries and Industrial Aspects of Physical Chemistry	Core	4	3
	CH2VOP01 Vocational Practical: Industrial Inorganic Chemistry (P)	Core	2	2
III	English III	Common	5	4
	CH3CRT03 Organic Chemistry-I	Core	3	3
	CH4CRP02 Qualitative Organic Analysis	Core	2	-
	Complementary Mathematics	Complementary	5	4
	CH3VOT03 Unit Operations in Chemical Industry	Core	3	4
	CH3VOT04 Unit Processes in Organic Chemicals Manufacture	Core	3	4
	CH2VOP02 Vocational Practical	Core	2	-
	CH2VOP03 Vocational Practical	Core	2	-
IV	English IV	Common	5	4
	CH4CRT04 Organic Chemistry-II	Core	3	3
	CH4CRP02 Qualitative Organic Analysis	Core	2	2
	Complementary Mathematics	Complementary	5	4
	CH4VOT05 Instrumental Methods of Chemical Analysis-I	Core	3	3
	CH4VOT06 Instrumental Methods of Chemical Analysis-II	Core	3	3
	CH2VOP02 Vocational Practical	Core	2	2
	CH2VOP03 Vocational Practical	Core	2	2
V	CH5CRT05 Environment, Ecology and Human Rights	Core	4	4
	CH5CRT06 Organic Chemistry-III	Core	3	3
	CH5CRT07 Physical Chemistry - I	Core	2	2
	CH5CRT08 Physical Chemistry - II	Core	2	3
	CH5OPT Open course	Open	4	3

	CH6CRP03 Qualitative Inorganic Analysis	Core	3	-
	CH6CRP04 Organic Preparations and Basic Laboratory Techniques	Core	2	-
	CH6CRP05 Physical Chemistry Practical	Core	3	-
	CH6PRP01Project	Core	2	-
VI	CH6CRT09 Inorganic Chemistry	Core	3	3
	CH6CRT10 Organic Chemistry-IV	Core	3	3
	CH6CRT11 Physical Chemistry - III	Core	3	3
	CH6CRT12 Physical Chemistry - IV	Core	3	3
	CH6CBT Choice Based Course	Core	3	3
	CH6CRP03 Qualitative Inorganic Analysis	Core	3	2
	CH6CRP04 Organic Preparations and Basic Laboratory Techniques	Core	2	2
	CH6CRP05 Physical Chemistry Practical	Core	3	2
	CH6CRP06 Gravimetric Analysis	Core	2	2
	CH6PRP01 Project, Industrial visit and comprehensive viva - voce	Core	-	2
	CH6OJP01 OJT	Core	-	2

On the Job Training All the students have to undergo on the job training in a chemical industry for a minimum period of 15 days and submit a project report. The period of 15 days need be at a single stretch. The vacation days may be utilized for this purpose. A report of the training should be submitted to the department during the sixth semester for internal evaluation.

OPEN COURSES:

Sl. No.	Semester	Course Code	Course Title
1	V	CH5OPT1.1	Chemistry in Everyday Life
2	V	CH5OPT1.2	Nanoscience and Nanotechnology
3	V	CH5OPT1.3	Forensic Science

CHOICE BASED COURSES:

Sl. No.	Semester	Course Code	Course Title
1	VI	CH6CBT1.1	Polymer Chemistry
2	VI	CH6CBT1.2	Nanochemistry and Nanotechnology
3	VI	CH6CBT1.3	Soil and Agricultural Chemistry

3. B.Sc CHEMISTRY PROGRAMME – (MODEL - III)

Sem	Title with Course code	Course Category	Hours per week	Credits
I	English I	Common	5	4
	CHICRT01 General and Analytical Chemistry	Core	2	2
	CH2CRP01 Volumetric Analysis	Core	2	-
	CH1PCT01 Petroleum Geology	Core	4	3
	CH2PCP01 Practical I	Core	2	-
	Complementary Mathematics	Complementary	5	3
	Complementary Computer Science	Complementary	3	2
	Complementary Practical –I	Complementary	2	-
II	English I	Common	5	4
	CH2CRT02 Theoretical and Inorganic Chemistry	Core	2	2
	CH2CRP01 Volumetric Analysis	Core	2	2
	CH2PCT02 Test Methods and Petroleum Processes	Core	4	3
	CH2PCP01 Practical I	Core	2	2
	Complementary Mathematics	Complementary	5	3
	Complementary Computer Science	Complementary	3	3
	Complementary Practical –I	Complementary	2	2
III	CH3CRT03 Organic Chemistry-I	Core	3	3
	CH4CRP02 Qualitative Organic Analysis	Core	2	-
	CH3PCT03 Production and Application of Compounds from Petroleum	Core	4	4
	CH3PCT04 Manufacture of Petrochemicals-I	Core	3	4
	CH4PCP02 Practical –II	Core	2	-
	Complementary Mathematics	Complementary	5	4
	Complementary Computer Science	Complementary	4	3
	Complementary Practical –II	Complementary	2	-
IV	CH4CRT04 Organic Chemistry-II	Core	3	3
	CH4CRP02 Qualitative Organic Analysis	Core	2	2
	CH4PCT05 Manufacture of Petrochemicals-II	Core	4	4
	CH4PCT06 Petroleum Industries in India	Core	3	4
	CH4PCP02 Practical –II	Complementary	2	2
	Complementary Mathematics	Complementary	6	4
	Complementary Computer Science	Complementary	3	3
	Complementary Practical –II	Core	2	2
V	CH5CRT05 Environment, Ecology and Human Rights	Core	4	4
	CH5CRT06 Organic Chemistry-III	Core	3	3
	CH5CRT07 Physical Chemistry - I	Core	2	2
	CH5CRT08 Physical Chemistry - II	Core	2	3
	CH5OPT Open course	Open	4	3
	CH6CRP03 Qualitative Inorganic Analysis	Core	3	-

	CH6CRP04 Organic Preparations and Basic Laboratory Techniques	Core	2	-
	CH6CRP05 Physical Chemistry Practical	Core	3	-
	CH6PRP01Project	Core	2	-
VI	CH6CRT09 Inorganic Chemistry	Core	3	3
	CH6CRT10 Organic Chemistry-IV	Core	3	3
	CH6CRT11 Physical Chemistry - III	Core	3	3
	CH6CRT12 Physical Chemistry - IV	Core	3	3
	CH6CBT Choice Based Course	Core	3	3
	CH6CRP03 Qualitative Inorganic Analysis	Core	3	2
	CH6CRP04 Organic Preparations and Basic Laboratory Techniques	Core	2	2
	CH6CRP05 Physical Chemistry Practical	Core	3	2
	CH6CRP06 Gravimetric Analysis	Core	2	2
	CH6PRP01 Project, Industrial visit and comprehensive viva-voce	Core	-	2
	CH6OJP01 OJT	Core	-	3

On the Job Training All the students have to undergo on the job training in a chemical industry for a minimum period of 15 days and submit a project report. The period of 15 days need be at a single stretch. The vacation days may be utilized for this purpose. A report of the training should be submitted to the department during the sixth semester for internal evaluation.

OPEN COURSES:

Sl. No.	Semester	Course Code	Course Title
1	V	CH5OPT1.1	Chemistry in Everyday Life
2	V	CH5OPT1.2	Nanoscience and Nanotechnology
3	V	CH5OPT1.3	Forensic Science

CHOICE BASED COURSES:

Sl. No.	Semester	Course Code	Course Title
1	VI	CH6CBT1.1	Polymer Chemistry
2	VI	CH6CBT1.2	Nanochemistry and Nanotechnology
3	VI	CH6CBT1.3	Soil and Agricultural Chemistry

SYLLABUS FOR
CHEMISTRY CORE COURSES

SEMESTER I

CH1CRT01 – GENERAL AND ANALYTICAL CHEMISTRY Credits: 2

(36 Hrs)

Unit 1: Methodology of Chemistry (7 Hrs)

Definition of Science. Scientific methods - observation-posing a question - formulation of hypothesis- experiment – theory - law. Falsification of hypothesis - inductive and deductive reasoning- revision of scientific theories and laws.

Evolution of Chemistry-ancient speculation on the nature of matter. Early form of chemistry-alchemy, origin of modern chemistry. Structure of chemical science: Scope, theory and experiment - branches of chemistry. Role of chemistry as a central science connecting physics, biology and other branches of science. Interdisciplinary areas involving chemistry: Nanotechnology and biotechnology.

Unit 2: Periodic Table and Periodic Properties (5 Hrs)

Modern periodic law – Long form periodic table. Diagonal relationship and anomalous behavior of first element in a group. Periodicity in properties: Atomic and ionic radii - ionization enthalpy - electron affinity (electron gain enthalpy) – electronegativity. Electronegativity scales: Pauling and Mullikan scales. Effective nuclear charge – Slater rule and its applications – polarising power.

Unit 3: Analytical Methods in Chemistry (12 Hrs)

Molecular mass - mole concept – molar volume. Oxidation and reduction – oxidation number and valency – variable valency - equivalent mass.

Qualitative analysis: Applications of solubility product and common ion effect in the precipitation of cations. Principle of intergroup separation of cations. Interfering acid radicals and their elimination (oxalate, fluoride, borate and phosphate).

Titrimetric analysis - fundamental concepts. Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm. and ppb. Primary and secondary standards, quantitative dilution – problems. Acid base titrations- titration curves – pH indicators. Redox titrations – titration curve –titrations involving MnO_4^- and $Cr_2O_7^{2-}$ - redox indicators. Complexometric titrations – EDTA titrations - titration curves – metal ion indicators. Gravimetric analysis: Unit operations in gravimetric analysis - illustrations using iron and barium estimation. Separation and purification techniques – filtration, crystallization and precipitation – fractional distillation, solvent extraction.

Unit 4: Chromatographic Methods (7 Hrs)

Column Chromatography: Principle, types of adsorbents, preparation of the column, elution, recovery of substances and applications. Thin Layer Chromatography: Principle, choice of adsorbent and solvent, preparation of Chromatoplates, Rf-values, significance of Rf values. Ion exchange chromatography: Principle and experimental techniques. Gas Chromatography: Principle and experimental techniques. High Performance Liquid Chromatography (HPLC): Principle and experimental techniques.

Unit 5: Evaluation of Analytical Data (5 Hrs)

Units, significant digits, rounding, scientific and prefix notation, graphing of data. Precision and accuracy-types of errors – ways of expressing precision – ways to reduce systematic errors - reporting analytical data. Statistical treatment of analytical data – population and samples – Mean and standard deviation – distribution of random errors.

References

1. J.A.Lee, Scientific Endeavour, Addison Wesley Longman
2. C.N.R.Rao, University General Chemistry, MacMillan India (Ltd.)
3. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
4. J. D. Lee, Concise Inorganic Chemistry, 5th edn., Blackwell Science, London, 2010.
5. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
6. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1,* 5th Edition, S. Chand and Sons, New Delhi, 2012.
7. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
8. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.
9. Vogels Textbook of Quantitative Chemical Analysis, 6thEdn., Pearson Education Ltd.

SEMESTER II

CH2CRT02 – THEORETICAL AND INORGANIC CHEMISTRY

Credits - 2 (36 hrs)

Unit 1: Atomic Structure (6 Hrs)

Introduction based on historical development (Dalton's atomic theory, Thomson's atom model Rutherford's atom model) - failure of classical physics – black body radiation - Planck's quantum hypothesis - photoelectric effect - generalization of quantum theory . Atomic spectra of hydrogen and hydrogen like atoms– Bohr theory of atom – Calculation of Bohr radius, velocity and energy of an electron - explanation of atomic spectra - limitations of Bohr theory

- Sommerfeld modification. Louis de Broglie's matter waves – wave-particle duality - electron diffraction - Heisenberg's uncertainty principle.

Schrödinger wave equation (derivation not expected), wave functions – significance of ψ and ψ^2 – atomic orbitals and concept of quantum numbers - shapes of orbitals (*s, p* and *d*) - Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – electronic configuration of atoms.

Unit 2: Chemical Bonding – I (9 Hrs)

Introduction – Octet rule and its limitations.

Types of bonds: Ionic bond - factors favouring the formation of ionic bonds - lattice energy of ionic compounds - Born- Lande equation with derivation - solvation enthalpy and solubility of ionic compounds – Born-Haber cycle and its applications – properties of ionic compounds - polarisation of ions – Fajan's rule and its applications.

Covalent Bond: Valence Bond Theory and its limitations. Concept of resonance - resonance structures of borate, carbonate and nitrate ions. Hybridization: Definition and characteristics – shape of molecules ($BeCl_2$, C_2H_2, BF_3, C_2H_4, CH_4, NH_3, H_2O, NH_4^+, H_3O^+, PCl_5, SF_6 and IF_7). VSEPR theory: Postulates - applications - shapes of molecules CCl_4, NH_3, H_2O, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6.

Properties of covalent compounds - polarity of bonds – percentage of ionic character – dipole moment and molecular structure.

Unit 3: Chemical Bonding – II (9 Hrs)

Covalent Bond: Molecular Orbital Theory – LCAO - bonding and anti-bonding molecular orbitals – bond order and its significance. MO diagrams of homonuclear and heteronuclear diatomic molecules: H_2, He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, CO and NO – comparison of bond length, magnetic behavior and bond energy of O_2, O_2^+, O_2^{2+}, O_2^- and O_2^{2-} . Metallic Bond: free electron theory, valence bond theory and band theory (qualitative treatment only) - explanation of metallic properties based on these theories.

Intermolecular forces: Hydrogen bond - intra and inter molecular hydrogen bonds – effect on physical properties. Van der Waals forces, ion-dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole and induced dipole-induced dipole interactions

Unit 4: Chemistry of s and p Block Elements (3 Hrs)

Periodicity in s-and p- block elements with respect to electronic configuration, atomic and ionic size, ionization energy and electro negativity. Inert pair effect.

Unit 5: Chemistry of d and f Block Elements (9 Hrs)

Transition Metals: General characteristics: Metallic character, oxidation states, size, density, melting points, boiling points, ionization energy, colour, magnetic properties, reducing properties, catalytic properties, non-stoichiometric compounds, complex formation and alloy formation. Difference between first row and other two rows. Preparation, properties, structure and uses of $KMnO_4$ and $K_2Cr_2O_7$.

Lanthanides: Electronic configuration and general characteristics – Occurrence of lanthanides

Isolation of lanthanides from monazite sand - Separation by ion exchange method.

Lanthanide contraction: Causes and consequences. Industrial importance of lanthanides.

References

1. R.K. Prasad, *Quantum Chemistry*, New Age International, 2001
2. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books.
3. I. N. Levine, *Physical Chemistry*, Tata McGraw Hill,
4. ManasChanda, *Atomic structure and Chemical bonding in Molecular Spectroscopy"* Tata McGraw Hill.
5. J. D. Lee, Concise Inorganic Chemistry, 5th edn., Blackwell Science, London.
6. B. R. Puri, L. R. Sharma, Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi.
7. F. A. Cotton, G. Wilkinson and P. L. Gaus, Basic Inorganic Chemistry, 3rd edn., John Wiley.
8. B. Douglas, D. Mc Daniel, J. Alexander, Concepts and models in Inorganic Chemistry.
9. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1,* 5th Edition, S. Chand and Sons, New Delhi, 2012.
10. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.

SEMESTER I AND II - CORE CHEMISTRY PRACTICALS

CH2CRP01 - VOLUMETRIC ANALYSIS

Credits: 2 (72 Hrs)

A. Acidimetry and Alkalimetry

1. Strong acid-Strong base
2. Strong acid – Weak base
3. Strong base – Weak acid
4. Estimation of $Na_2CO_3$and $NaHCO_3$ in a mixture
5. Estimation of NaOH and Na_2CO_3 in a mixture
6. Estimation of ammonia in ammonium salts by direct and indirect methods

B. Complexometric Titrations Using EDTA

1. Estimation of Zn
2. Estimation of Mg
3. Estimation of Mg and Ca in a mixture
4. Estimation of Ni
5. Determination of hardness of water

C. Oxidation – Reduction Titrations

(i) Permanganometry

1. Estimation of ferrous iron
2. Estimation of oxalic acid
3. Estimation of sodium oxalate
4. Estimation of calcium

(ii) Dichrometry

1. Estimation of ferrous iron using internal indicator
2. Estimation of ferrous iron using external indicator
3. Estimation of ferric iron using internal indicator
4. Estimation of ferric iron using external indicator

(iii) Iodimetry and Iodometry

1. Estimation of copper
2. Estimation of arsenious oxide

References:

1. A. I. Vogel ‘A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis’: (Third Ed.) (ELBS)
2. D.A.Skoog, D.M.West and S.R.crouch, Fundamentals of Analytical Chemistry, 8^{th}Edn., Brooks/Cole Nelson.
3. Vogels Textbook of Quantitative Chemical Analysis, 6^{th}Edn., Pearson Education Ltd.

SEMESTER III

CH3CRT03 - ORGANIC CHEMISTRY – I

Credits – 3 (54 Hrs)

(Reaction mechanisms expected only wherever mentioned)

Unit 1: Fundamentals of Organic Chemistry (8 Hrs)

Classification and IUPAC system of nomenclature of common organic compounds (both aliphatic and aromatic).

Line diagram drawing. Factors affecting reaction mechanism. Polarity of bonds.

Electronic displacements: Inductive effect, electromeric effect, mesomeric effect, resonance and hyperconjugation. steric effects.

Cleavage of bonds: Homolysis and heterolysis with suitable examples. curly arrow rules, formal charges.

Types of reagents: Nucleophiles and electrophiles.

Reactive intermediates: Carbocations, carbanions, free radicals and carbenes – types, shape and relative stability.

Types of organic reactions: Addition, elimination, substitution, rearrangement and redox reactions (definition and one example each).

Unit 2: Stereochemistry (15 Hrs)

Stereoisomerism – definition, classification.

Optical isomerism: Optical activity, specific rotation, concept of chirality (upto two carbon atoms). Configuration. Enantiomerism, diastereomerism and meso compounds. Racemic mixture and methods of resolution. Asymmetric synthesis (partial and absolute). Threo and erythro; *d* and *l* designations; Cahn-Ingold-Prelog rules: R/ S notation (for upto 2 chiral carbon atoms).

Geometrical isomerism: cis–trans, *syn-anti* and E/Z nomenclature (for upto two C=C systems) with C.I.P rules. Methods of distinguishing geometrical isomers.

Conformational analysis: Conformational analysis with respect to ethane, butane and cyclohexane. Relative stability and energy diagrams. Inter conversion of Wedge formula, Newman, Sawhorse and Fischer projection formulae. Chair, boat and twist boat forms of cyclohexane with energy diagrams. Conformation of methyl cyclohexane.

Origin of ring strain in cyclic systems. Baeyer's strain theory.

Unit 3: Aliphatic Hydrocarbons and Alkyl Halides (12 Hrs)

Alkanes: Preparation - catalytic hydrogenation, Wurtz reaction, Wurtz-Fittig reaction, from Grignard reagent. Reactions - free radical substitution - halogenation.

Alkenes: Preparation - Elimination reactions - mechanism of E1 and E2 reactions. Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's and Hofmann's rules). Reactions - *cis*-addition (alkaline $KMnO_4$) and *trans*-addition (bromine). Addition of HX (Markownikoff's and anti-Markownikoff's addition with mechanisms), Hydration, Ozonolysis.

Alkynes: Preparation - Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides. Reactions - Acidity of alkynes, formation of metal acetylides, alkylation of terminal alkynes and conversion into higher alkynes, addition of bromine and alkaline $KMnO_4$.

Alkyl Halides: Preparation - From alkenes and alcohols. Reactions - Types of aliphatic nucleophilic substitution reactions - S_N1 and S_N2 mechanisms with stereochemical aspects and effects of substrate structure, solvent, nucleophile and leaving group.

Organometallic compounds of Mg (*Grignard reagents*) – Formation, structure and important reactions/synthetic applications.

Unit 4: Aromatic Hydrocarbons and Aryl Halides (15 Hrs)

Aromaticity : Definition, Hückel's rule - application to benzenoid (benzene, naphthalene and anthracene) and non-benzenoid (cyclopropenyl cation, cyclopentadienyl anion and tropylium cation) compounds.

Benzene: Molecular orbital picture and resonance energy. Preparation - from phenol, by decarboxylation, from acetylene, from aromatic acids. Reactions - Electrophilic aromatic substitution: nitration, halogenation, sulphonation and Friedel-Craft's reaction (alkylation and acylation) with their mechanism. Orientation of aromatic substitution. *ortho, para* and *meta* directing effects of groups. Ring activating and deactivating groups with examples.

Naphthalene and Anthracene: Molecular orbital picture and resonance energy. Preparation - (of Naphthalene): Haworth synthesis

Reactions - Electrophilic substitutions (halogenation, nitration and sulphonation) of naphthalene.

Aryl Halides: Preparation - chloro, bromo and iodo-benzene from phenol, Sandmeyer and Gattermann reactions. Reactions - aromatic nucleophilic substitutions – bimolecular displacement mechanism, elimination-addition (benzyne intermediate) mechanism.

Unit 5: Pericyclic Reactions (4 Hrs)

Classification – electrocyclic reactions, cycloadditions - Diels-Alder reaction and Sigmatropic rearrangements - Claisen rearrangement (with mechanism).

References

1. Morrison, R.T., Boyd, R.N. & Bhattacharjee, S.K. *Organic Chemistry*, 7th ed., Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
2. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons, 2014.
3. McMurry, J. *Organic Chemistry*, 7th ed. Cengage Learning, 2013.
4. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, 1988.
5. Eliel, E.L. & Wilen, S.H. *Stereochemistry of Organic Compounds*, Wiley, 1994.
6. Finar, I.L. *Organic Chemistry* (Vol. 1 & 2), Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
7. Jain, M.K. & Sharma, S.C. *Modern Organic Chemistry*, Vishal Publishing Co. 2010.
8. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.

9. Kalsi, P. S. *Stereochemistry - Conformation and Mechanism*; New Age International, 2005.
10. Pillai, C.N. *Organic Chemistry*, Universities Press, 2008.
11. Gupta, S.S. *Organic Chemistry*, Oxford University Press, 2014.

SEMESTER IV

CH4CRT04 - ORGANIC CHEMISTRY –II

Credits – 3 (54 Hrs)

(Reaction mechanisms expected only wherever mentioned)

Unit 1: Alcohols, Phenols and Ethers (16 Hrs)

Alcohols

Preparation - 1^{o}, 2^{o} and 3^{o} alcohols using Grignard reagent, ester hydrolysis, reduction of aldehydes, ketones, carboxylic acids and esters (Bouveault-Blanc reduction). Reactions - with sodium, HX (Lucas test), esterification, oxidation (with PCC, alkaline $KMnO_4$, OsO_4, acidic dichromate, conc. HNO_3). Oppenauer oxidation (with mechanism). Ascent and descent of alcohol series.

Diols: Preparation - hydroxylation of alkenes, hydrolysis of epoxides. Reactions - oxidative cleavage of diols using lead tetraacetate and periodic acid. Pinacol - Pinacolone rearrangement (with mechanism).

Phenols: Preparation -cumene hydroperoxide method, from diazonium salts. Reactions - Electrophilic substitution - nitration, halogenation and sulphonation. Reimer- Tiemann reaction and Fries rearrangement (with mechanisms).

Preparation and uses of nitrophenols, picric acid, resorcinol and quinol.

Ethers and Epoxides: Preparation - ethers and epoxides - Williamson's ether synthesis. Reactions of ethers - cleavage with HI. Zeisel's method of estimation of alkoxy groups. Reactions of epoxides - with alcohols, ammonia derivatives and $LiAlH_4$.

Unit 2: Aldehydes and Ketones (20 Hrs)

Preparation, properties and reactions of formaldehye, acetaldehyde, acetone, benzaldehyde and benzophenone.

Preparation - from alcohols, acid chlorides, esters and nitriles.

Reactions - Structure of the carbonyl group and acidity of α-hydrogen. (i) Addition reactions - with HCN, ROH, $NaHSO_3$, Grignard reagents and ammonia derivatives. Aldol, Claisen, Claisen-Schmidt, Knoevenagel and Benzoin condensations (with mechanisms). Cannizzaro reaction, Wittig reaction and Mannich reaction (with mechanisms). Michael addition (with mechanism) (ii) Oxidation reactions - Tollen's and Fehling's tests, Iodoform test, Baeyer-Villiger oxidation (with mechanism) (iii) Reduction reactions - Clemmensen, Wolff-Kishner, Meerwein-Pondorff-Verley, $LiAlH_4$, and $NaBH_4$ reductions (with mechanisms) (iv) Rearrangement reactions - Beckmann, and benzil-benzilic acid rearrangements (with mechanisms).

Unit 3: Carboxylic Acids, Sulphonic Acids and their Derivatives (18 Hrs)

Carboxylic acids (aliphatic and aromatic)

Preparation - Oxidation of alcohols and aldehydes, hydrolysis of nitriles, side chain oxidation and carbonylation of grignard reagents. Acidic and alkaline hydrolysis of esters.

Reactions - structure of carboxylate ion, effect of substituents on acid strength. Ascent and descent of acid series. Reduction and decarboxylation reactions. Reactions with PCl_5, PCl_3

and $SOCl_2$. Reaction with ammonia, esterification and halogentaion. Hell – Volhard - Zelinsky reaction (with mechanism).

Carboxylic acid derivatives (aliphatic):

Preparation - acid chlorides, anhydrides, esters and amides from acids. Reactions - comparative study of nucleophilicity of acyl derivatives. Perkin condensation and Reformatsky reaction (with mechanisms).

Dicarboxylic acids, hydroxy acids and unsaturated acids

Methods of formation, important reactions and uses of dicarboxylic acids, hydroxy acids and unsaturated acids like oxalic acid, malonic acid, adipic acid, phthalic acid, citric acid, salicylic acid, cinnamic acid, anthranilic acid, acrylic acid, maleic acid and fumaric acid.

Sulphonic acids and their derivatives

Preparation, reactions and uses of benzene sulphonic acid, benzene sulphonyl chloride and *ortho*- and *para*- toluene sulphonyl chlorides.

References

1. Morrison, R.T., Boyd, R.N. & Bhattacharjee, S.K. *Organic Chemistry*, 7th ed., Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
2. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, Wiley, 2014.
3. McMurry, J. *Organic Chemistry*, 7th ed. Cengage Learning, 2013.
4. Finar, I.L. *Organic Chemistry* (Vol. 1), Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
5. Carey, F.A., Giuliano, R.M. *Organic Chemistry*, 8th ed., Tata McGraw Hill,.2012
6. Jain, M.K. & Sharma, S.C. *Modern Organic Chemistry*, Vishal Publishing Co. 2010.
7. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
8. Tewari, K.S. & Vishnoi, N.K. *Organic Chemistry*, Vikas Publishing House, 2012.
9. Pillai, C.N. *Organic Chemistry*, Universities Press, 2008.
10. Gupta, S.S. *Organic Chemistry*, Oxford University Press,

SEMESTER III AND IV ORGANIC CHEMISTRY

PRACTICALS- I

CH4CRP02 - QUALITATIVE ORGANIC ANALYSIS

Cridit-2 (72 Hrs)

1. Determination of physical constants of solids and liquids – melting and boiling points.
2. Tests for elements: Nitrogen, Halogens and Sulphur
3. Tests for unsaturation.
4. Tests for aromatic character.
5. Study of the reactions of the following functional groups: carboxylic acid, 1,2-dicarboxylic acid, phenol, aldehyde, ketone, ester, reducing and nonreducing sugars, polynuclear hydrocarbon, primary, secondary and tertiary amines, amides, diamide, nitro and halogen compounds.
6. Systematic analysis and preparation of solid derivative of the following organic compounds: carboxylic acid, 1,2-dicarboxylic acid, unsaturated acids, phenol, hydroxy acids, aldehyde, ketone, ester, reducing and nonreducing sugars, polynuclear hydrocarbon, primary, secondary and tertiary amines, amide, diamide, nitro and halogen compounds.
   (Minimum twelve compounds to be analysed)

References

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V. Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry,* 5th ed., Pearson Education, 2005.
2. Mann,F.G.; Saunders, B.C. *Practical Organic Chemistry*, 4th ed., Pearson Education, 2009.
3. Ahluwalia, V.K.; Dhingra, S. *Comprehensive Practical Organic Chemistry – Qualitative Analysis,* Universities Press, 2000.
4. Vishnoi, N.K. *Advanced Practical Organic Chemistry*, 3rd ed., Vikas Publishing House, New Delhi, 2010.

SEMESTER V

CH5CRT05 - Environment, Ecology and Human Rights

Credits – 4 (72 Hrs)

Environmental Chemistry (54 h)

Objectives: Environmental awareness is to understand the fragility and sensitivity of our environment, in particular the biosphere and the importance of its protection. Promoting environmental awareness is an easy way to become an environmental steward and participate in creating a brighter future for our next generations. The most important goal of this paper is to impart awareness on various environmental aspects, with some glimpses of contemporary issues. This will help them foster a *sense* of responsibility and "*proactive citizenship*".

Module I: Introduction to environmental studies: Natural resources

10 h

Definition, scope and importance of environmental studies for sustainable development, need for public awareness.

Natural Resources: Classification of natural resources; renewable and non-renewable resources:

Natural resources and associated problems;

1.1 Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

1.2 Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

1.3 Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

1.4 Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, industrial farming of livestock and effects on global warming, fertilizer-pesticide problems, water logging, salinity. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, mass production of biodiesel for energy needs and *food security*. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Module II: Environment: Pollution and Social Issues

18 h

Fundamental ideas of pollution and pollutant. Cause, effects and preventive measures of various types of pollutions including; air, water, soil, marine, noise and thermal pollutions. Nuclear energy as a source of energy and its hazards. Solid waste management; causes, effects and control mechanisms of urban and industrial wastes. Prevention of pollution: role of individual. Disaster management mechanisms; disaster management of; floods, earthquake, cyclone and landslides.

Movement from unsustainable to sustainable development. Urban crisis related to energy. Water conservation, rain water harvesting, watershed management, Environmental ethics: Issues and possible solutions. Introduction to important green house gases (GHGs), sources of the primary greenhouse gases in Earth's atmosphere including water vapor, carbon dioxide, methane. The lesser GHGs- nitrous oxide, ozone and fluorinated gases. Carbon cycle, CO_2 sources, Keeling curve and Natural 'sinks' for CO_2. Green house effect, climate change, global warming, acid rain, ozone layer depletion, role of CFCs in ozone depletion, and

its mechanism, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Environment Protection Act (EPA). Air (prevention and control of pollution) Act. Water (prevention and control of pollution) Act, Wildlife Protection Act, Forest Conservation Act. Issues involved in the enforcement of environmental legislation. Introduction to the concept of green chemistry, atom economy (with suitable examples) and the twelve principles of green chemistry.

Module III: Population and Environmental issues

8 h

Human population growth, *Malthusian theory (basic idea) and* theory of evolution by natural selection, *Malthusian* catastrophe. Global challenges, *environmental* problems of population growth, impacts on human health and welfare, variation among nations, population explosion and Family Welfare Programme. Socio- economic, and geo-political dimensions of poverty, absolute and relative poverty, poverty scale, variation among nations, international food crisis. Resettlement and rehabilitation of project affected population. Environmental movements in India: Chipko, Silent valley, Bishnois of Rajasthan etc.

Module IV: Ecological Chemistry

18 h

Definition and scope of ecological chemistry, ecological stress posed upon ecosystems by the presence of chemicals. Origin of chemical toxicants; natural sources, and man-made. Organization of chemicals as xenobiotic, essential or nonessential substances. Release of chemicals in the environment, Transport Processes, Classification of transformation processes, biotic and abiotic. Structure- activity relationships in degradation and biodegradation of organic chemicals. Transformation processes including general, hydrolysis, oxidation, reduction, photochemical degradation, microbial degradation, and phytodegradation, environmental fate determining processes, bioavailability, exposure of species to (bio)available fractions, uptake (accumulation), metabolism, biomagnifications, distribution in organisms, and subsequent toxic effects. Risk assessment of chemicals-assessment of contaminated soils.

Persistent organic pollutants (POPs), natural and anthropogenic origin of POCs and characteristic properties; half-lives, K_{ow}, K_{aw} and K_{oa}. Adverse effects of persistent chemicals. Legislation on the use of POPs and twelve persistent organic pollutants. The sources, the uses, some of the physico-chemical properties, the half-lives in the environmental compartments of air, water and soil. Behaviour of the priority persistent organic pollutants identified by the United Nations Economic Commission for Europe (UNECE) including; polychlorinated biphenyls, dieldrin, aldrin, dichlorodiphenyltrichloroethane (DDT), Mirex, Heptachlor and Polychlorinated furans. Agency for Toxic Substances and Disease Registry (ATSDR) list, **the ATSDR 2017 Substance Priority List,** Restriction of Hazardous Substances (RoHS) directive, Material Safety Data Sheet (MSDN), Toxic Substances Control Act (TSCA) and banned/severely restricted chemicals list.

Suggested reference books

1. S. Manahan, *Fundamentals of environmental chemistry*, CRC-Press, 1993.
2. S. Manahan, *Fundamentals of Environmental and Toxicological Chemistry*: Sustainable Science, CRC Press, 2013
3. R.C. Brunner, *Hazardous Waste Incineration*, McGraw Hill Inc., 1989
4. W.P. Cunningham, T.H. Cooper, E Gorhani, and M.T. Hepworth, *Environmental Encyclopedia*, Jaico Publishing House, Mumbai, 2001.
5. A.K. De, *Environmental Chemistry*, Wiley Eastern Ltd.
6. V. Subramanian, *A Textbook of Environmental Chemistry*, I.K. International Publishing House Pvt. Ltd. 2011.
7. S.K. Tiwari, *Environmental Science: Volume I and II*, Atlantic Publishers and Distributers Pvt. Ltd., 2011.

8. R. M. Harrison (ed.), *Understanding Our Environment An Introduction to Environmental Chemistry and Pollution*, Royal Society of Chemistry, 1999
9. D. E. Newton, *Chemistry of the Environment***,** Facts On File Inc., 2007
10. V. Udai, Modern *Teaching of Population Education*, Anmol Publications Pvt. Ltd., 2005.
11. B. McGuire, Global *Catastrophes: A Very Short Introduction*, Oxford University Press, 2002.
12. A. E. Dessler, E. A. Parson, *The Science and Politics of Global Climate Change*, Cambridge University Press, 2006.
13. J. Firor, J. Jacobsen, *The Crowded and Greenhouse- Population, Climate Change, and Creating a Sustainable World,* Yale University Press, 2002.
14. B. Lomborg, *Cool It: The Skeptical Environmentalist's Guide to Global Warming*, Alfred A. Knopf Publisher- New York, 2007.

Further readings

1. S. V. S. Rana, *Essentials of Ecology and Environmental Science*, 5th Edition, Rupa publications, 2013.
2. V.H. Heywood, and R.T. Waston, *Global Biodiversity Assessment*. Cambridge Univ. Press, 1995.
3. H. Jadhav, V.M. Bhosale, *Environmental Protection and Laws*. Himalaya Pub. House, Delhi, 1995.
4. M.L. Mckinney, and R.M. School, *Environmental Science Systems and Solutions*, Web enhanced edition. 1996.
5. P. H., H. Raven, D.M. Hassenzahl, and L. R. Berg, *Environment*, 8th Edn. John Wiley & Sons, 2012.
6. A. Wreford, D. Moran, N. Adger , *Climate Change and Agriculture: impacts, adaptation and mitigation*, OECD publications, 2010.
7. R.S. Boethling D. Mackay, *Handbook of Property Estimation Methods for Chemicals.* Boca Raton, FL, USA: Lewis Publishers, 2000.
8. J.L.M. Hermens C. J. Van Leeuwen *Risk Assessment of Chemicals: An Introduction, Dordrecht,* The Netherlands, Kluwer Academic Press, 1995.
9. D. Mackay, W.Y.,Shiu, K.C. Ma *Physical-Chemical Properties and Environmental Fate, Degradation Handbook.* (CD-ROM), Boca Raton, FL, USA, Chapman & Hall CRC netBASE, CRC, 1999.
10. W. J. G. M. Peijnenburg, *Ecological Chemistry, Environmental and Ecological Chemistry- Vol. III, Encyclopedia of Life Support Systems* (EOLSS).
11. M. Ali, *Climate Change Impacts on Plant Biomass Growth*, Springer Dordrecht Heidelberg, 2013

Special Notes and Suggestions:

The purpose of the paper is to create general awareness on various dimensions of environmental sciences with a special focus on contemporary issues. The BoS in Chemistry recommend case studies or sample surveys (maybe in groups) rather than seminars. Students can undertake an assignment based on any of the following highly relevant and current topic;

- Edutainment film *"Samaksham",* produced by Mahatma Gandhi University, Kottayam.
- Case Studies on the *important natural resources* of Kerala.
- Case Studies on the Indian *mining scams and consequent environmental* damages of; illegal mining in the *Aravali Ranges, Goa, Ganges river bed, Bellary* etc.
- Case Studies on the *disaster management mechanisms* of floods, landslides, earthquake, cyclone etc.
- Case Studies on the water conservation, rain water harvesting, watershed management in a local contest.
- Case studies on environmental movements like Narmada Bachao Andolan, Appiko Movement, Save Ganga Movement etc.

Module - V (18 h)

V.I Human Rights

An Introduction to Human Rights, meaning, concept and development –History of Human Rights- Different Generations of Human Rights- Universality of Human Rights- Basic International Human Rights Documents - UDHR, ICCPR, ICESCR.-Value dimensions of Human Rights

V-II Human Rights and United Nations

Human Rights co-ordination within UN system- Role of UN secretariat- The Economic and Social Council-The Commission (of) Human Rights?-The Security Council and Human rights- The Committee on the Elimination of Racial Discrimination- The Committee on the Elimination of Discrimination Against Women- the Committee on Economic, Social and Cultural Rights- The Human Rights Committee- Critical Appraisal of UN Human Rights Regime.

V-III Human Rights National Perspective

Human Rights in Indian Constitution – Fundamental Rights- The Constitutional Context of Human Rights- directive Principles of State Policy and Human Rights- Human Rights of Women-children –minorities- Prisoners- Science Technology and Human Rights- National Human Rights Commission- State Human Rights Commission- Human Rights Awareness in Education.

References and suggested readings

1. H.O. Agarwal, *Implementation of Human Rights Covenants with Special Reference to India*,
2. P. Alston, *The United Nations and Human Rights*, Clarendon Press, London, 1995.
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13. UN Centre for Human Rights, Minority Rights, World Campaign for Human Rights, Geneva, , 1998.
14. UN Centre for Human Rights, *Human Rights Machinery*, World Campaign for Human Rights, Geneva, 1987.
15. Ian Brownlie, *Basic Documents Human Rights*
16. Jack Donelli, *Universal Human Rights in Theory and practice*
17. Upendra Baxi, *Future of Human Rights*
18. O P Dhiman, *Understanding Human Rights-An Overview*
19. D P Khanna, *Reforming Human Rights*
20. Chiranjivi J Nirmal, *Human Rights in India-Historical, social and political perspectives*

21. *Human Rights in Post-Colonial India,* Edited by Om Prakash Dwivedi and V G Julie Rajan

CH5CRT06 - ORGANIC CHEMISTRY - III

(Reaction mechanisms expected only wherever mentioned)

Credits – 3 (54 Hrs)

Unit 1: Nitrogen Containing Compounds (15 Hrs)

Nitro compounds (aliphatic and aromatic):

Preparation: Methods of preparation of nitroalkanes and aromatic nitro compounds**.**

Reactions: Tautomerism of nitromethane. Reduction products of nitrobenzene in acidic, neutral and alkaline media. Electrolytic reduction and selective reduction of polynitro compounds. Formation of charge transfer complexes. **Amines** (aliphatic and aromatic):

Preparation: From alkyl halides, Reduction of nitro compounds and nitriles, Reductive amination of aldehydes and ketones, Gabriel's phthalimide synthesis, Hofmann bromamide reaction (with mechanism).

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2. Separation of a mixture of 1°, 2° and 3° amines using Hinsberg reagent. Stereochemistry of amines. Structural features affecting basicity of aliphatic and aromatic amines. Comparative study of aliphatic and aromatic amines. Schotten – Baumann Reaction (with mechanism). Electrophilic substitution reactions of aniline: Halogenation, nitration and sulphonation. Quaternary amine salts as phase-transfer catalysts.

Diazonium salts:

Preparation: From aromatic amines.

Reactions: Structure and stability of benzene diazonium salts. Conversion to benzene, phenol, chloro, bromo, iodo and fluoro benzenes, nitro benzene and azo dyes. Mechanisms of Sandmeyer and Gatterman reactions. Schiemann and Gomberg reactions. Preparation, structure and uses of Phenyl hydrazine, Diazomethane and Diazoacetic ester. Arndt –Eistert synthesis – Mechanism of Wolff rearrangement.

Unit 2: Heterocyclic Compounds (8 Hrs)

Classification and nomenclature. Structure and aromaticity of 5-numbered and 6-membered rings containing one heteroatom. Synthesis and reactions of: Furan, Thiophene, Pyrrole (Paal-Knorr synthesis and Knorr pyrrole synthesis), Pyridine (Hantzsch synthesis), Indole (Fischer's indole synthesis), Quinoline (Skraup synthesis and Friedlander's synthesis) and Isoquinoline (Bischler-Napieralski reaction).

Unit 3: Active Methylene Compounds (5 Hrs)

Preparation: Ethyl acetoacetate by Claisen ester condensation.

Reactions: Keto-enol tautomerism. Synthetic uses of ethylacetoacetate, diethyl malonate and ethyl cyanoacetate (preparation of non-heteromolecules only). Alkylation of carbonyl compounds *via* enamines.

Unit 4: Carbohydrates (11 Hrs)

Classification of carbohydrates. Reducing and non-reducing sugars. General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Chain lengthening and chain shortening of aldoses - Kiliani-Fischer synthesis and Wohl degradation. Interconversion of aldoses and ketoses.Linkage between monosaccharides. Structure of the disaccharides sucrose, maltose and cellobiose (excluding their structure elucidation). Reactions and uses of sucrose. Artificial sugars (sweeteners) – sucralose. Structure of the polysaccharides starch and cellulose (excluding their structure elucidation). Industrial applications of cellulose.

Unit 5: Drugs (5 Hrs)

Classification of drugs. Structure, therapeutic uses and mode of action (synthesis not required) of Antibiotics: Ampicillin and Chloramphenicaol, Sulpha drugs: Sulphanilamide, Antipyretics: Paracetamol, Analgesics: Aspirin and Ibuprofen, Antimalarials: Chloroquine, Antacids: Ranitidine, Anti- cancer drugs: Chlorambucil and Anti-HIV agents: Azidothymidine (Zidovudine). Psychotropic drugs: Tranquilizers, antidepressants and stimulants with examples. Drug addiction and abuse. Prevention and treatment.

Unit 6: Dyes (4 Hrs)

Theories of colour and chemical constitution. Classification of dyes – according to chemical constitution and method of application. Natural and synthetic dyes. Synthesis and applications of: Azo dyes – Methyl orange; Triphenyl methane dyes - Malachite green and Rosaniline; Phthalein dyes – Phenolphthalein and Fluorescein; Indigoid dyes - Indigotin; Anthraquinoid dyes – Alizarin. Edible dyes (Food colours) with examples.

Unit 7: Polymers (6 Hrs)

Introduction and classification. Polymerisation reactions - Addition and condensation - Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes. Preparation and applications of plastics – thermosetting (Phenol-formaldehyde, Urea-formaldehyde, Polyurethane) and thermosoftening (Polythene, PVC); Fibres (acrylic, polyamide, polyester). Synthetic rubbers – SBR, Nitrile rubber and Neoprene. Introduction to conducting polymers with examples. Environmental hazards and biodegradability of polymers. Recycling of plastics.

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7. John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds,* Prentice Hall.
8. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of Organic Compounds*, Wiley.
9. Pillai, C.N. *Organic Chemistry*, Universities Press, 2008.
10. Gupta, S.S. *Organic Chemistry*, Oxford University Press, 2014.

CH5CRT07 – PHYSICAL CHEMISTRY - I

Credits – 2 (36 Hrs)

Unit 1: Gaseous State (12 Hrs) Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena and Andrews isotherms of CO_2, critical constants and their calculation from van der Waals equation. Virial equation of state, van der Waals equation expressed in virial form.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphical representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation).

Collision properties: Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Relation between mean free path and coefficient of viscosity.

Unit 2: Liquid State (3 Hrs) Intermolecular forces in liquids (qualitative idea only). Surface tension and its

measurement by stalagmometer method, factors affecting Surface tension, Viscosity, Poisuelle's equation, Determination of viscosity by Ostwald's viscometer..

Unit 3: Solid State (12 Hrs)

The nature of the solid state – anisotropy –Forms of solids. Unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography – Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Bragg's X-ray diffractometer method and powder pattern method. Analysis of powder diffraction patterns of NaCl and KCl, density of cubic crystals.

Structure of ionic compounds of the type AX (NaCl, CsCl, ZnS) and AX2 (CaF2, Na2O) Defects in crystals – stoichiometric and non-stoichiometric defects, extrinsic and intrinsic defects. Electrical conductivity, semiconductors, n-type, p-type, Superconductivity – An introduction.

Liquid crystals and its thermographic behaviour. Classification, structure of nematic and cholestric phases.

Unit 4: Surface Chemistry and Colloidal State (9 Hrs)

Adsorption – types, adsorption of gases by solids – factors influencing adsorption – Freundlich adsorption isotherm – Langmuir adsorption isotherm –derivation of Langmuir adsorption isotherm. The BET theory (no derivation) – use of BET equation for the determination of surface area.

Types of solutions – true, colloid and suspensions, Purification of colloids – Ultra filtration and electrodialysis, optical and electrical properties of colloids. Electrical double

layer and zeta potential. Coagulation of colloids, Hardy-Schulz rule. Micelles and critical micelle concentration, sedimentation and streaming potential.

References

1. R P W Atkins, *"Physical Chemistry"*, Oxford University Press
2. R J Silby and R A Alberty, *"Physical Chemistry"*, John Wiley & Sons
3. F Daniels and A Alberty, *"Physical Chemistry"*, Wiley Eastern
4. Puri, Sharma and Pathania, *"Principles of Physical Chemistry"*, Millennium Edition, Vishal Publishing Co
5. Barrow, G.M. "*Physical Chemistry*",Tata McGraw-Hill (2007).
6. Castellan, G.W. "*Physical Chemistry"*,4th Ed. Narosa (2004).
7. K. L. Kapoor, "*A Textbook of Physical chemistry"*, Volume 1, Macmillan India Ltd.,
8. B. R. Puri, L. R. Sharma, M. S. Pathania, "*Elements of Physical chemistry"*, Vishal Pub. Co.,
9. L V Azaroff, *"Introduction to Solids"*, McGraw Hill.
10. N B Hannay, *"Solid State Chemistry"*, Prentice Hall.
11. A. McQuarrie, J. D. Simon, *"Physical Chemistry – A molecular Approach"*, Viva Books Pvt. Ltd.
12. Anthony R. West, *"Solid State Chemistry and its Applications"*, Wiley Eastern.

CH5CRT08 – PHYSICAL CHEMISTRY – II
Credits - 3 (36 Hrs)

Unit 1: Quantum Mechanics (14 Hrs)

Classical mechanics: Concepts, Radiation phenomena –Blackbody radiation, Photoelectric effect, Compton effect and Atomic spectra. Plank's quantum theory and explanation of the radiation phenomena.de Broglie hypothesis, dual nature of electrons – Davisson and Germer's experiment. Heisensberg's uncertainty principle and its significance.

Postulates of quantum mechanics: Schrodinger wave equation – significance of Ψ, well behaved wave functions, Concept of operators- Operator algebra – Linear and Hermitian operators - Laplacian and Hamiltonian operators – Eigen functions and Eigen values of an operator.

Application of quantum mechanics to simple systems – Particle in 1-D box, normalization of wave function, application to linear conjugated polyene (butadiene). Introductory treatment of Schrödinger equation for hydrogen atom.– The wave equation in spherical polar coordinates (derivation not required) - Separation of wave equation - Radial and angular functions (derivation not required) – Orbitals. Quantum numbers and their importance, hydrogen like wave functions – radial and angular wave functions, radial distribution curves.

Molecular orbital theory: basic ideas – criteria for forming MO from AOs, construction of molecular orbital by LCAO method for H_2^+ion (elementary idea only), physical picture of bonding and antibonding wave functions, concept of σ, σ*, π, π* orbitals and their characteristics.

Unit 2: Molecular Spectroscopy-I (12 Hrs)

Introduction: electromagnetic radiation, regions of the spectrum, interaction ofelectromagnetic radiation with molecules, various types of molecular spectroscopic techniques, Born-Oppenheimer approximation.

Rotation spectroscopy: Introduction to rotational spectroscopy, Rotational energy levels, Selection rules.

Vibrational spectroscopy: Introduction, Selection Rules, Classical equation of vibration, calculation of force constant, concept of anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands. Degrees of freedom for polyatomic molecules, modes of vibration (H_2O and CO_2 as examples), finger print region, Fermi resonance.

Raman spectroscopy: Introduction, Classical and quantum treatment of Raman effect, Qualitative treatment of Rotational Raman effect; Vibrational Raman spectra, Stokes and anti-Stokes lines: their intensity difference, rule of mutual exclusion.

Unit 3: Molecular Spectroscopy-II (10 Hrs)

Electronic spectroscopy: Introduction, selection rule, Franck-Condon principle, electronic transitions, singlet and triplet states, dissociation and predissociation. Polyatomic molecules – qualitative description of σ, π and n- molecular orbitals, their energy levels and the respective transitions. Lambert-Beer's law.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling.

Electron Spin Resonance (ESR) spectroscopy: Principle, hyperfine structure, ESR of simple radical - methyl radical.

References

1. R.K. Prasad, *Quantum Chemistry*, New Age International, 2001
2. Mc Quarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books.
3. I. N. Levine, *Physical Chemistry*, Tata McGraw Hill,
4. Banwell, C. N. &Mc Cash, E. M. *Fundamentals of Molecular Spectroscopy*,4th Ed. Tata McGraw-Hill: New Delhi (2006).
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7. D. N. Satyanarayana, *Electronic absorption spectroscopy and related techniques*, Universities Press.
8. D.N. Sathyanarayana, Introduction To Magnetic Resonance Spectroscopy ESR, NMR, NQR, IK International, 2009.
9. Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
10. GurdeepRaj, *Photochemistry*, 6thEdn, Goel Publishing House, 2014
11. Rohatgi-Mukherjee, *Fundamentals of Photochemistry*, New Age International (P) Ltd.
12. Puri, Sharma &Pathania, *Priniciples of Physical Chemistry*, Vishal Publishing Co.
13. N. J. Turro, *Modern Molecular Photochemistry*, 4th Edition University Science Books,Sausalito, 1991.
14. Gurdeep Raj, *"Advanced Physical Chemistry"*, Goel Publishing House

CH5OPT – OPEN COURSE

Mahatma Gandhi University, Kottayam

CH5OPT02 - NANOSCIENCE AND NANOTECHNOLOGY

Credits – 3 (72 Hrs)

Unit 1: Hitory of Nanotchnology (18 Hrs)

Historical landmarks- terminology-scales. Top-down and bottom-up paths in nanoscience. Feynman's hypothesis-Moore's law -Types of nanomaterials: fullerene- its discovery-production-contribution to nanotechnology-unusual properties of fullerene. Nanotubes:carbon nanotubes- synthesis- properties and applications.

Unit 2: Nanoscience: Its Social, Economic and Ethical Perspectives (18 Hrs)

Existing laws and regulations of nanotechnology- regulatory agencies- intellectual property policy of nanotechnology. Energy challenges-environmental impacts of nanotechnology - green nanotechnology- technology business: nano economics- entrepreneurs in the technological ecosystem- nanoethics - future of nanotechnology.

Unit 3: Seeing the Nanoworld (18 Hrs)

Fundamental particles-elctromagnetic radiation- its components- impact on matter-the Planck's equation- de Broglie relation- matter-wave concept of radiation- concept of colour and vision-Auxochromes and chromophores- spectroscopic methods and radiation-elementary ideas of UV-visible, XPES and UPES techniques, SEM, TEM, SPL, and SIMS - their use in the studies of nanosystems (theory is not expected).

Unit 4: Applications of Nanotechnology (18 Hrs)

Nanobiology and its applications- Nanomedicines- immuno targeted drug delivery--nanoparticle drug systems for oral, nasal, and ocular administration- nanomaterials in medical diagnosis - therapeutic applications. Nanosensors- smart dusts. Destructive applications of nanotechnology.

References

1. T. Pradeep, Nano: The Essentials, Mc Graw Hill Publishing Company, New Delhi (2007).
2. V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009.
3. C. N. R. Rao and A.Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005).
4. J. M. M. Duart, R. J. M. Palma and F.A. Rueda,Nanotechnology and Microelectronics and optoelectronics, Elsevier (2002).
5. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008.
6. K. J. Klabunde, Nanoscale materials in chemistry, John Wiley and Sons.
7. C. P. Poole Jr and F J Owens, Introduction to nanotechnology, Wiley IndiaPvt Ltd 2009.
8. L. E. Foster, Nanotechnology: Science, Innovation and Opportunity, Pearson Education (2008).
9. http://www.zyvex.com/nanotech/feynman.html

SEMESTER VI

CH6CRT09 - INORGANIC CHEMISTRY

Credits - 3 (54 Hrs)

Unit 1: Coordination Chemistry - I (7 Hrs)

Introduction of coordination compounds, Types of ligands – Anionic, cationic and neutral – IUPAC Nomenclature, Isomerism in coordination compounds –Structural isomerism and stereo isomerism . Chelates, chelate effect-Stability of complexes: Inert and labile complexes - Factors influencing stability. Review of Werner's theory and Sidgwick's concept of coordination – EAN rule.

Unit 2: Coordination Chemistry - II (14 Hrs)

Bonding theories: Valence bond theory - Geometries of coordination numbers 4 and 6 – Inner orbital and outer orbital complexes- Limitations of VBT. Crystal filed theory - Splitting of *d*-orbitals in octahedral, tetrahedral, tetragonal and square planar complexes - Jahn Teller Effect– Jahn –Teller distortion in Cu(II) complexes. Factors affecting crystal field splitting - CFSE of low spin and high spin octahedral complexes. Spectrochemical series - Explanation of geometry, magnetism and spectral properties - Merits and demerits of Crystal field theory. Molecular orbital theory – evidence for metal ligand covalency- MO diagram for octahedral complexes (with sigma bonds only).

Unit 3: Cooridnation Chemistry III (6 Hrs)

Spectral and magnetic properties of complexes – electronic absorption spectrum of $[Ti(H_2O)_6]^{3+}$, Calculation of magnetic moments – spin only formula. Reactivity of complexes – Ligand substitution reactions- SN_1 and SN_2 substitution reactions of square plananr complexs- Trans effect and its applications. Application of coordination chemistry in qualitative and quantitative analysis of metal ions such as Cu^{2+}, Zn^{2+}, Ni^{2+} and Mg^{2+}.

Unit 4: Organometallic Compounds (12 Hrs)

Definition – Classification based on the nature of metal-carbon bond and on the basis of hapticity. Naming of organometallic compounds. The 18- electron rule and stability – Ferrocene: Preparation, properties and bonding (VBT only). Metal-alkene complexes- – Zeise's salt. Catalytic properties of organometallic compounds - Zeigler Natta catalyst in the polymerization of alkene and Wilkinson catalyst in the hydrogenation of alkene (mechanism not expected). Preparation and properties of mononuclear carbonyls - Structures of $Mo(CO)_6$, $Fe(CO)_5$ and $Ni(CO)_4$. Polynuclear carbonyls, bridged carbonyls and bonding in carbonyls – $Mn_2(CO)_{10}$ and $Fe_2(CO)_9$. EAN of metals in metal carbonys – indication of metal-metal bonding. - Quadruple bond – structure of $Re_2CI_8^{2-}$.

Unit 5: Bioinorganic Chemistry (6 Hrs)

Essential and trace elements in biological systems – Structure and functions of haemoglobin and myoglobin, Vitamin B12 (structure not expected). Electron carriers – cytochromes. Chlorophyll and photosynthesis (mechanism not expected).

Role of alkali and alkaline earth metals in biological systems, Na/K pump. Importance of Ca and Mg. Biological functions and toxicity of metals – Fe, Cu, Zn, Cr, Mn, Ni, Co, Cd, Hg and Pb. Metalloenzymes of zinc and copper, nitrogenase. Treatment of metal toxicity by chelation therapy. Anti cancer drugs – cis platin and carboplatin– Structure and significance.

Unit 6: Boron Compounds (3 Hrs)

Preparation, properties and structure of diborane, borazine, boric acid, boron nitride.

Unit 7: Inter-halogen and Noble Gas Compounds (6 Hrs)

Interhalogens - classification- general preparation- structures of AB, AB_3, AB_5 and AB_7 types. Reactivity (ClF, ICl_3, ClF_3, IF_5 and IF_7). Comparison of pseudohalogens with halogens. Electropositive character of iodine. Separation of noble gases (charcoal adsorption method). Compounds of noble gases.

References

1. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edition, Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry–Principles ofStructure and Reactivity*, 4th Edition, Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, New York, 2010.
4. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
5. P.L. Soni and Mohan Katyal, *Textbook of Inorganic Chemistry*, 20th Edition, S. Chand and Sons, New Delhi, 2013.
6. Satya Prakash, *Advanced Inorganic Chemistry, Volume 2,* S. Chand and Sons, New Delhi, 2005.
7. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi 2008.
8. R. Gopalan and V. Ramalingam, *Concise Coordination Chemistry,* 1st Edition, Vikas Publishing House, New Delhi, 2001.
9. Wahid U. Malik, G D. Tuli and R.D. Madan, Selected Topics in Inorganic Chemistry, S. Chand and Co., New Delhi, 2010 (Reprint).

SEMESTER VI

CH6CRT10 - ORGANIC CHEMISTRY - IV

Credits - 3 (54 Hrs)

Unit 1: Natural Products (6 Hrs)

Terpenoids

Terpenoids – Classification. Isoprene rule. Structure elucidation and uses of citral and geraniol. Natural rubber - structure, latex processing methods, vulcanisation, rubber compounding, mastication and uses.

Alkaloids

Alkaloids - General methods of isolation. Classification. Physiological action and medicinal importance. Structure elucidation and synthesis of coniine, nicotine and piperine.

Unit 2: Lipids (6 Hrs)

Introduction to lipids. Classification.

Oils and fats: Biological functions. Extraction and refining. Common fatty acids present in oils and fats. Omega fatty acids. Trans fats and their effect. Hydrogenation, Rancidity. Acid value, Saponification value, Iodine value and RM value.

Biological functions of waxes, phospholipids and glycolipids.

Soaps - Types of soaps. Cleansing action of soaps.

Synthetic detergents - Classification. Detergent additives. Comparison between soaps and detergents. Environmental aspects. ABS and LAS detergents.

Unit 3: Vitamins, Steroids and Hormones (6 Hrs)

Vitamins

Vitamins – Classification. Structure, biological functions and deficiency diseases of vitamins A, B_1, B_2, B_3, B_5, B_6, C and D.

Steroids

Steroids – Introduction. Diels' hydrocarbon. Structure and functions of cholesterol.

Elementary idea of HDL and LDL.

Hormones

Hormones – Introduction. Examples and biological functions of steroid hormones, peptide hormones and amine hormones (structure not required). Artificial hormones.

Unit 4: Amino Acids, Peptides and Proteins (8 Hrs)

Classification of amino acids. Synthesis, ionic properties and reactions of α-amino acids. Zwitterion structure and Isoelectric point.

Polypeptides. Synthesis of simple peptides (upto tripeptides) by N-protecting (benzyloxycarbonyl and *t*-butyloxycarbonyl) & C-activating groups. DCC method. Merrifield's solid phase peptide synthesis.

Classification of proteins. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of proteins. Determination of N-

terminal amino acid (by FDNB and Edman method) and C–terminal amino acid (by hydrazinolysis and with carboxypeptidase enzyme). Helical and sheet structures. Denaturation of proteins.

Unit 5: Nucleic Acids (4 Hrs)

Components of Nucleic acids: Adenine, guanine, cytosine, thymine and uracil (structure only), other components of nucleic acids. Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson - Crick Model) and RNA. Biological functions of DNA and RNA - Replication and protein biosynthesis. Transcription and Translation. Genetic code.

Unit 6: Enzymes (3 Hrs)

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes.

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereospecificity). Enzyme inhibitors and their importance. Uses of enzymes.

Unit 7: Supramolecular Chemistry (3 Hrs) Introduction. Molecular recognition. Host-guest interactions. Types of non-covalent

interactions and molecular receptors. Role of molecular recognition in biopolymer (DNA and protein) structure organisation (elementary idea only).

Unit 8: Organic Photochemistry (4 Hrs)

Introduction. Photochemical versus Thermal reactions. Electronic excitation and fate of excited molecules. Jablonski diagram. Fluorescence and phosphorescence. Photosensitisation. Photochemical reactions: Norrish type I and II reactions of acyclic ketones, Paterno-Buchi reaction and Photo-Fries reaction (with mechanisms).

Unit 9: Organic Spectroscopy (14 Hrs)

UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λ_{max} for the following systems: α,β-unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between *cis* and *trans* isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O and N containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in

alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.

Applications of IR, UV and NMR for identification of simple organic molecules.

Mass Spectrometry: Introduction. EI ionisation. Determination of molecular mass by MS (elementary idea only – fragmentation study not required).

References

1. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
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3. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry,* 7th ed., W. H. Freeman.
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11. Steed, J. W. & Atwood, J.L. *Supramolecular Chemistry*, 2nd ed., Wiley, 2009.
12. Dodziuk, H. *Introduction to Supramolecular Chemistry*, Springer, 2002.

CH6CRT11 – PHYSICAL CHEMISTRY – III

Credits – 3 (54 Hrs)

Unit 1: Thermodynamics-I (15 Hrs)

Basic concepts- system, surroundings, types of systems. Extensive and intensive properties, macroscopic properties. State functions and path functions. Types of Processes, Zeroth law of thermodynamics. Definition of internal energy and enthalpy. Heat capacities at constant volume (C_v) and at constant pressure (C_p), relationship between C_p and C_v.

First law of thermodynamics –Mathematical statement of first law. Reversible process and maximum work. Calculation of work, heat, internal energy change and enthalpy change for the expansion of an ideal gas under reversible isothermal and adiabatic condition.

The Joule-Thomson effect – derivation of the expression for Joule-Thomson coefficient. Sign and magnitude of Joule-Thomson coefficient, inversion temperature. Liquefaction of gases.

Thermochemistry – standard states. Enthalpies of formation, combustion and neutralization. Integral and differential enthalpies of solution. Hess's law and its applications. Kirchoff's equation.

Unit 2: Thermodynamics-II (12 Hrs)

Second law: Limitations of first law – Different statements of II^{nd} law, Thermodynamic scale of temperature. Carnot cycle and its efficiency, Carnot theorem.

Concept of entropy – Definition and physical significance. Entropy as a function of volume and temperature, Entropy as a function of pressure and temperature. Entropy as a criteria of spontaneity and equilibrium.

Gibbs and Helmholtz free energies and their significances- criteria of equilibrium and spontaneity. Gibbs-Helmholtz equation, dependence of Gibbs free energy change on temperature, volume and pressure. Third law of thermodynamics-statement and determination of absolute entropies of substances.

Unit 3: Chemical Equilibria (3 Hrs) Law of mass action-equilibrium constant – Relation between Kp, Kc and Kx –

Thermodynamic treatment of the law of mass action – Vant Hoff reaction isotherm – Temperature dependence of the equilibrium constant – The Van't Hoffs equation –Pressure dependence of the equilibrium constant Kp.

Unit 4: Ionic Equilibria (8 Hrs) Introduction – Concepts of acids and bases, relative strength of acid-base pairs,

influence of solvents, Dissociation constants – acids, bases, and polyprotic acids. Ostwald's dilution law.

Degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water-pH. Effects of solvents on ionic strength..

Buffer solutions – Mechanism of buffer action, Henderson equation. Hydrolysis of salts – degree of hydrolysis and hydrolysis constant, determination of degree of hydrolysis, pH of salt solutions.

Unit 5: Phase equilibria (6 Hrs)

The phase rule-derivation, equilibrium between phases – conditions. One component system – water system, sulphur system. Two component systems – solid-liquid equilibrium – Simple Eutectic, Lead- Silver system, Formation of compounds with Congruent Melting Point; Ferric chloride–Water system, Formation of compounds with Incongruent Melting Point Sodium sulphate–Water system.

Unit 6: Chemical Kinetics (10 Hrs)

Rate of reaction, rate equation, order and molecularity of reactions, determination of order of a reaction. Integrated rate expressions for first and second order reactions ($2A \rightarrow P$ and $A + B \rightarrow P$). Zero order reactions, pseudo order reactions, half life.

Theories of chemical kinetics: Effect of temperature on the rate of reaction: Arrhenius equation, concept of activation energy, Collision theory, Transition state theory. Thermodynamic parameters for activation – Eyring equation (no derivation needed),enthalpy and entropy of activation. Theory of unimolecular reactions – Lindemann Theory.

Kinetics of complex (composite) reactions: Opposing reactions, consecutive reactions, and parallel (simultaneous) reactions. Chain reactions – steady state treatment, Hydrogen– Bromine reaction- derivation of rate expression.

Catalysis: Homogeneous catalysis, enzyme catalysis – Michaelis–Menten equation (no derivation needed). Heterogeneous catalysis – Surface catalysis, Elementary idea about Autocatalysis.

References

1. R. P. Rastogi, R. R. Misra, *An Introduction to Chemical Thermodynamics*, 6th edn., Vikas Pub. Pvt. Ltd. (2003).
2. P. Atkins and J Paula, *The elements of Physical chemistry*, 7thedn., Oxford University Press.
3. K.K. Sharma, L.K. Sharma, *A Textbook of Physical Chemistry*, 4thedn, Vikas publishing House.
4. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical chemistry*, Vishal Pub. Co. Jalandhar
5. J. Rajaram and J. C. Kuriakose, *Thermodynamics*, ShobanLalNagin Chand & Co (1986).
6. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular* Approach, Viva Books Pvt. Ltd.
7. F. A. Alberty and R. J .Silby, *Physical Chemistry*, John Wiley.
8. F Daniels and R A Alberty, *Physical Chemistry*, Wiley Eastern.
9. Gurdeep Raj, *Advanced Physical Chemistry*, Goel Publishing House.
10. S. Glasstone, *Thermodynamics for Chemists*, Affiliated East West Publishers.
11. G.S. Rush Brooke, *Statistical Mechanics*, Oxford University Press.
12. K. L. Kapoor, A *Textbook of Physical chemistry, Volumes 3*, Macmillan India Ltd.
13. Gurdeep Raj, *Chemical Kinetics*, Krishna's Educational Publishers (2014).
14. K. J. Laidler, *Chemical kinetics*, 3rdedn, Pearson education, 2004.

CH6CRT12– PHYSICAL CHEMISTRY – IV

Credits – 3 (54 Hrs)

Unit 1: Solutions (12 Hrs)

Introduction – Binary liquid solutions – Raoult's law- ideal and non-ideal solutions– OG_{mix}, OV_{mix}, and OS_{mix} for ideal solutions. Vapour pressure – composition and temperature– composition curves of ideal and non-ideal binary liquid solutions. Fractional distillation of binary liquid-liquid solutions – distillation of immiscible liquids, partially miscible liquid-liquid systems. Critical solution temperature (CST).

Solubility of gases in liquids – Henry's law. Distribution of a solute between two solvents– Nernst distribution law.

Partial molar quantities – Chemical potential – Gibbs–Duhem equation. Colligative properties of dilute solutions – vapour pressure lowering, Boiling point elevation and freezing point depression (thermodynamic derivation).Molar mass determination-related problems – Osmotic pressure –laws of osmotic pressure – Reverse osmosis – purification of sea water. Abnormal molecular masses – van't Hoff factor – Degree of association and Degree of dissociation.

Unit 2: Electrical Conductance (12 Hrs)

Introduction- Faraday's laws of electrolysis, electrochemical equivalent& chemical equivalent. Electrolytic conductivity, molar conductivity – Variation of molar conductivity with concentration. Kohlrausch's law – Applications.

Ionic mobility – relation with ion conductivity, influence of temperature on ion conductivity, ion conductivity and viscosity – Walden's rule. Abnormal ion conductivity of hydrogen and hydroxyl ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods.

Debye-Hückel theory of strong electrolytes – the concept of ionic atmosphere, Asymmetry and electrophoretic effect, Debye- Hückel-Onsager equation (no derivation). Activity, mean ionic activity and mean ionic activity coefficients of electrolytes. Ionic strength of a solution, Debye-Hückel limiting law (no derivation).

Applications of conductance measurements – Determinations of degree of dissociation of weak electrolytes, determination of solubility and solubility products of sparingly soluble salts, conductometric titrations involving strong acid- strong base, weak acid- strong base, mixture of a strong acid and weak acid against strong base and precipitation titrations.

Unit 3: Electromotive Force (15 Hrs)

Introduction –Electrochemical cells and electrolytic cells, Galvanic cells, characteristics of reversible cells. Reversible electrodes – Different types, Reference electrodes – Standard Hydrogen Electrode, Calomel electrode, Electrode potential – Electrochemical series. Representation of cells, Electrode reactions and cell reactions

Derivation of Nernst equation for electrode potential and cell potential, Gibb's Helmholtz equation and EMF of a cell, calculation of OG, OH and OS from EMF data. Calculation of equilibrium constant from EMF data.

Concentration cells – Electrode concentration cell and electrolyte concentration cells. Types of electrolyte concentration cells – with transference and without transference, liquid junction potential and salt bridge. Fuel cells – the hydrogen-oxygen fuel cell.

Applications of emf measurements – determination of solubility product, determination of pH using hydrogen electrode, quinhydrone electrode and glass electrode.

Potentiometric titrations of acid-base and redox reaction, oxidation reduction indicators. Irreversible electrode processes – overvoltage.

Corrosion of metals – forms of corrosion, corrosion monitoring and prevention methods.

Unit 4: Photochemistry (6 Hrs)

Laws of photochemistry-Grothus-Draper law, Stark-Einstein law. Jablonsky diagram-qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). Quenching of fluorescence.

Quantum yield, examples of low and high quantum yields, photochemical reactions (decomposition of HBr, isomerisation of maleic acid to fumaric acid), photosensitised reactions (photosynthesis, isomerization of 2-butene), chemiluminescence, bioluminescence..

Unit 5: Group Theory (9 Hrs)

Elements of symmetry – Proper and improper axis of symmetry, plane of symmetry, centre of symmetry and identity element. Combination of symmetry elements, Schoenflies symbol, Point groups, C_2V, C_3V and D_3h, Group multiplication table of C_2V, Determination of point groups of simple molecules like H_2O, NH_3 and BF_3.

References

1. B. R. Puri, L. R. Sharma, M. S. Pathania, *Elements of Physical chemistry*, VishalPub. Co. Jalandhar.
2. K. L. Kapoor, *A Textbook of Physical chemistry*, *Volume 4*, Macmillan India Ltd.
3. Barrow, G.M. *Physical Chemistry*,Tata McGraw-Hill (2007).
4. Castellan, G.W. *Physical Chemistry*,4th Ed. Narosa (2004).
5. Kotz, J.C., Treichel, P.M. & Townsend, J.R., *General Chemistry*, Cengage Learning India Pvt. Ltd. New Delhi (2009).
6. Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
7. K. L. Kapoor, *A Textbook of Physical chemistry*, *Volumes 1*, Macmillan India Ltd,
8. Glasstone S, *An Introduction to Electrochemistry*, East-West Press (Pvt.) Ltd. (2006).
9. Gurdeep Raj, *Advanced Physical Chemistry*, Goel publishing house.
10. Glasstone and Lewis, *Elements of Physical Chemistry*, Macmillan

11. K. L. Kapoor, *A Textbook of Physical chemistry*, *Volumes 3*, Macmillan IndiaLtd.
12. I.N. Levine, *Physical Chemistry*, Tata McGraw Hill
13. F A Alberty and R J Silby, *Physical Chemistry*, John Wiley.
14. P. W. Atkins,*The elements of Physical chemistry*, 8thedn, Oxford UniversityPress.
15. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt.Ltd.
16. S. H. Marron and J. B. Lando, *Fundamentals of Physical Chemistry*, MacmillanLtd.
17. G. K. Vemulapalli, *Physical Chemistry*, Prentice-Hall of India Pvt. Ltd. (1997) V Ramakrishnan and M S Gopinathan, *"Group Theory in Chemistry"*, Vishal Publishing.

PRACTICALS
SEMESTER V & VI

CH6CRP03 - QUALITATIVE INORGANIC ANALYSIS

Credit – 3 (108 Hrs)

1. Study of the reactions of the following radicals with a view to their identification and confirmation. Ag^{+} , Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+} , Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Mg^{2+}, Li^{+} , Na^{+} , K^{+} , $NH4^{+}$. $CO3^{2-}$, $S2^{-}$, $SO4^{2-}$, NO3', F^{-}, Cl^{-}, Br^{-} , $BO2^{-}$, $C2O4^{2-}$, $C4H4O6^{2-}$, $CH3COO^{-}$, $PO4^{3-}$, $AsO3^{3-}$, $AsO4^{3-}$ and $CrO4^{2}$-
2. Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the above list without interfering radical and with one interfering radical by Semi-micro method only. (Minimum of 10 mixtures to be analysed)

References

1. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)
2. G. Svehla, Text Book of Vogel's Macro and Semi-micro Inorganic Analysis, revised, Orient Longman.
3. V. V. Ramanujam, 'Inorganic Semi micro Qualitative Analysis', The National Publishing Co., Chennai,
4. W. G. Palmer 'Experimental Inorganic Chemistry', Cambridge.

CH6CRP04 - ORGANIC PREPARATIONS AND LABORATORY TECHNIQUES

Crdits-2 (72 Hrs)

A. Basic Laboratory Techniques

1. Crystallisation – Any four compounds using ethyl acetate, ethanol, and water - Record the yield of recovery.
2. Distillation - Purification of water and ethyl acetate-Record the yield of recovery.
3. Solvent extraction – aniline from water - methyl benzoate from water - using ether-
4. Record the yield of recovery. (*Any two experiments shall be done*).

B. Organic Preparations

1. Oxidation (benzaldehyde to benzoic acid).
2. Hydrolysis (methyl salicylate or ethyl benzoate to the acid).
3. Nitration (*m*-dinitrobenzene and picric acid).

4. Halogenation (*p*-bromoacetanilide from acetanilide).
5. Acylation (Benzoylation of aniline, phenol, β-naphthol).
6. Esterification (benzoic acid ester).
7. Iodoform from acetone or ethyl methyl ketone.
8. Side chain oxidation (benzyl chloride to benzoic acid).
9. Claisen – Schmidt reaction: Dibenzal acetone from benzaldyde.

C. Chromatography

1. TLC - Separation and identification- Determination of Rf value of *o*-and *p*-nitroanilines,
   o- and *p*-chloroanilines, *p*-chlorophenol and *p*-nitrophenol, *p*-chloroaniline and *p*–nitroaniline, benzil and *o*-nitroaniline or any two amino acids.
2. Column Chromatography – Purification of *o*-nitro aniline, o-nitrophenol, benzil, m-dinitro benzene, benzene azo –β-naphthol (*non–evaluative*).

References

1. Furniss, B.S.; Hannaford, A.J.; Rogers, V. Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry,* 5th ed., Pearson Education, 2005.
2. Mann,F.G.; Saunders, B.C. *Practical Organic Chemistry*, 4th ed., Pearson Education, 2009.
3. Ahluwalia, V.K.; Aggarwal, R. *Comprehensive Practical Organic Chemistry – Preparation and Quantitative Analysis*, Universities Press, 2000.
4. Vishnoi, N.K. *Advanced Practical Organic Chemistry*, 3rd ed., Vikas Publishing House, New Delhi, 2010.

CH6CRP05 - PHYSICAL CHEMISTRY PRACTICALS

Credits 3 (108 hrs)

1. Viscosity – percentage composition of a mixture.
2. Heat of solution – KNO3, NH4Cl
3. Heat of neutralization
4. Determination of equivalent conductance of an electrolyte
5. Conductometric titration – strong acid *vs.* strong base, weak acid-strong base
6. Transition temperature of salt hydrates. (Sodium thiosulphate, sodium acetate)
7. Determination of the surface tension of a liquid(Drop number method or Drop weight method)
8. Critical solution temperature of phenol-water system.
9. Effect of electrolytes on the CST of phenol-water system.
10. Molecular weight determination by Rast's method. (using naphthalene,camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene etc. assolute.)
11. Kinetics of simple reactions eg. Acid hydrolysis of methyl acetate.
12. Potentiometric titration – Fe^{2+} *vs.* $Cr_2O_7^{2-}$, I^- *vs.* MnO^{4-}
13. Data analysis of kinetic experiments using spreadsheet program (determination of rate constant)

14. Determination of equivalence point of potentiometric and conductometric titrationsusing spreadsheet program.

References

1. W. G. Palmer: 'Experimental physical chemistry', Cambridge University Press.
2. J.B. Yadav: Advanced Practical Physical Chemistry Goel Publishing House.
3. R.C. Das and B. Behra; 'Experiments in Physical Chemistry', Tata McGraw hill.
4. K.K. Sharma : 'An Introduction of Practical Chemistry': Vikas Publishing House, New Delhi
5. Khosla, B. D.; Garg, V. C. &Gulati, A. *Senior Practical Physical Chemistry,*R. Chand & Co.: New Delhi (2011).

CH6CRP06 GRAVIMETRIC ANALYSIS

2 Credits (36 Hrs) – Semester VI only

1. Estimation of Barium as barium sulphate
2. Estimation of iron as Fe_2O_3
3. Estimation of sulphate as barium sulphate
4. Estimation of copper as cuprous thiocynate
5. Estimation of nickel as nickel dimethyl glyoxime.

References

1. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
3. G. D. Christian, Analytical Chemistry, JohnWiley and Sons.
4. R. D. Day, A. L. Uderwood, Quantitative analysis,

Semester VI

CHOICE BASED COURSES

CH6CBT01 - POLYMER CHEMISTRY

Credits – 3 (54 Hrs)

Unit 1: Introduction and History of Polymeric Materials (4 Hrs)

History of Polymers. Terminology. Different schemes of classification of polymers. Polymer nomenclature.

Unit 2: Mechanisms of Polymerization (6 Hrs)

Classification of polymerization processes. Mechanism of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations. Mechanism of copolymerization. Mechanism of ring opening and group transfer polymerisations.

Unit 3: Polymerisation Techniques (4 Hrs)

Polymerisation techniques: Bulk, solution, suspension and emulsion polymerisations. Melt, solution and interfacial polycondensation techniques.

Unit 4: Physical Properties of Polymers (14 Hrs)

Structure-Property relationships of polymers.

Crystallization and Crystallinity: Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. ***Molecular weight of polymers:*** Determination of Molecular Weight of Polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass Transition Temperature (T_g): Definition. Factors influencing glass transition temperature (T_g). T_g and molecular weight. T_g and melting point. Importance of T_g.

Unit 5: Reactions of Polymers (4 Hrs)

Hydrolysis, hydrogenation, addition, substitution, crosslinking, vulcanisation and cyclisation reactions.

Unit 6: Polymer Degradation (4 Hrs)

Types of degradation. Thermal, mechanical, photo and oxidative degradations of polymers.

Unit 7: Polymer Processing (4 Hrs)

Polymer processing techniques: Compression moulding, Injection moulding, Blow moulding, Extrusion moulding, Thermoforming, Die casting, Film casting, Rotational casting, Calendering and Spinning.

Unit 8: Chemistry of Commercial Polymers **(8 Hrs)**

Brief introduction to the preparation, structure, properties and applications of the following polymers: polyolefins (LDPE, HDPE and PP), poly(vinyl chloride), polystyrene, poly(vinyl acetate), acrylic polymers (PAN and PMMA), fluoro polymers (PTFE), aliphatic polyamides (Nylon 6,6 and Nylon 6), aromatic polyamides (Kevlar), polyesters (PET), formaldehyde resins (PF, UF and MF), polyurethanes, polycarbonates, epoxy resins.

Unit 9: Specialty Polymers **(6 Hrs)**

High temperature resistant and flame retardant polymers. Biomedical applications of polymers. Controlled drug delivery systems. Conducting polymers - polyacetylene, polyaniline, poly(p-phenylene sulphide), polypyrrole, polythiophene. Conduction mechanism and applications. Carbon nanotubes. Synthesis and applications (elementary idea only).

References

1. Carraher, C.E. *Seymour/Carraher's Polymer Chemistry,* 6th ed., Marcel Dekker, New York, 2003.
2. Odian, G. *Principles of Polymerization*, 4th ed., Wiley, 2004.
3. Billmeyer, F.W. *Textbook of Polymer Science*, 3rd ed., Wiley-Blackwell, 1984.
4. Gowariker, V.R., Viswanathan, N.V.; Sreedhar J. *Polymer Science*, 2nd ed., New Age, 2015.
5. Ghosh, P. *Polymer Science & Technology*, 2nd ed., Tata McGraw-Hill, New Delhi, 2002.
6. Lenz, R.W. *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.
7. Bahadur, R., Sastry, N.V. *Principles of Polymer Science*, Narosa, New Delhi, 2003.

Mahatma Gandhi University, Kottayam

SYLLABUS FOR B.Sc. CHEMISTRY (COMPLEMENTARY)

SEMESTER I

CH1CMT01 - BASIC THEORETICAL AND ANALYTICAL CHEMISTRY

(Common for students who have opted Life Sciences, Family & Community Science, Physical Sciences and Geology as core)

Credits - 2 (36 Hrs)

Unit 1: Atomic Structure and Chemical Bonding (9 Hrs)

Atomic Structure: Bohr atom model and its limitations, Dual nature of matter and radiation. Photoelectric effect, de Broglie equation, Heisenberg's uncertainty principle, Concept of orbital, Quantum numbers, shapes of orbitals (*s, p, d*), Electronic configuration of atoms - Aufbau principle, Hund's rule of maximum multiplicity, Pauli's exclusion principle.

Chemical Bonding: Introduction – Type of bonds. Ionic bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds and its applications. Covalent bond: Lewis theory - Valence bond theory – Coordinate bond. VSEPR theory and examples. Hybridisation: - sp^3, sp^2 and *sp* (ethane, ethene, ethyne). Intermolecular forces - Hydrogen bonding in H_2O - Dipole-dipole interactions.

Unit 2: Fundamental Concepts in Chemistry (9 hrs)

Periodic Properties: Modern periodic law – Long form of periodic table. Periodicity in properties: Atomic radii, ionic radii, ionization enthalpy, electron affinity (electron gain enthalpy) and electronegativity (Pauling scale). Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass. Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and millimoles.

Concept of Equilibrium: Acids and Bases - Arrhenius, Lowry-Bronsted and Lewis theories. Ionic product of water - pH and pOH, Strengths of acids and bases - K_a and K_b, pK_a and pK_b. Buffer solution. Preparation of buffer solution having a known pH. Solvation, solubility, solubility product, common ion effect and their applications.

Unit 3: Basic Principles of Analytical Chemistry (9 Hrs)

Laboratory Operations (*Non-evaluative*): Laboratory safety and first aid. Use of different glassware like pipette, burette, standard measuring flask, distillation apparatus; heating methods, filtration techniques, weighing principle in chemical balance, weighing in electronic balance.

Methods of Analysis: Volumetric method of analysis - General principles. Primary and secondary standards, criteria for primary standards, preparation of standard solutions, standardization of solutions, end point. Acid base, redox and complexometric titrations and corresponding indicators. Double burette method of titration: Principle and advantages. Microanalysis and its advantages. Gravimetric method of analysis: General principles.

Reporting of Analytical Data: Units, significant digits, rounding, scientific and prefix notation, graphing of data - Precision and accuracy – Types of errors – Ways of expressing precision – Methods to reduce systematic errors.

Separation and Purification Techniques: Recrystallisation, use of drying agents, sublimation. General principles of distillation, fractional distillation, distillation under reduced pressure. Solvent extraction.

Unit 4: Chromatographic Techniques (9 Hrs)

Chromatography - Principle of differential migration. Classification of chromatographic methods. Basic principle and uses of Thin layer chromatography (TLC), Paper chromatography (PC), R_f value, Column chromatography, Gas chromatography(GC), High performance Liquid chromatography (HPLC), Ion Exchange chromatography (IEC).

References

1. B. R. Puri, L. R. Sharma, M.S. Pathania, *Elements of Physical Chemistry*, 3rd edn. Vishal Pub. Co., 2008.
2. C. N. R. Rao, *University General Chemistry*, Macmillan, 2009.
3. Manas Chanda, *Atomic Structure and Molecular Spectroscopy.*
4. P. L. Soni, *Inorganic Chemistry* .
5. R. A. Day Junior, A.L. Underwood, *Quantitative Analysis*, 5th edn. Prentice Hall of India Pvt. Ltd. New Delhi, 1988.
6. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th edn. Pearson Education (2003).
7. R. Gopalan, *Analytical Chemistry*, S. Chand and Co., New Delhi.

SEMESTER II
CH2CMT02 - BASIC ORGANIC CHEMISTRY

(Common for students who have opted Life Sciences, Family & Community Science, Physical Sciences and Geology as core)

Credits – 2 (36 Hrs)

Unit 1: Fundamental Concepts of Organic Chemistry (9 Hrs)

Introduction: Origin of organic chemistry – Uniqueness of carbon – Homologous series. IUPAC nomenclature of alkyl halides, alcohols, aldehydes, ketones, carboxylic acids and amines. Structural isomerism: Chain isomerism, position isomerism, functional isomerism, metamerism and tautomerism. Arrow formalism in organic chemistry. Bond fission - homolytic and heterolytic fission. Types of reagents - Electrophiles and nucleophiles. Polarity of bonds. Reaction Intermediates: Carbocations, carbanions and free radicals (preparation, structure, hybridization and stability). Types of organic reactions: Addition, Elimination, Substitution, Rearrangement and Redox reactions (definition and one example each).

Unit 2: Mechanisms of Organic Reactions (9 Hrs)

Meaning of reaction mechanism. Polarity of bonds. Electron Displacement Effects: Inductive effect - Definition - Characteristics - +I and -I groups. Applications: Explanation of substituent effect on the acidity of aliphatic carboxylic acids. Mesomeric effect: Definition – Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene and phenol. Hyperconjugation: Definition – Characteristics. Applications: Baker-Nathan effect, Comparison of stability of 2-methyl-1-butene & 2-methyl-2-butene. Steric effect (causes and simple examples).

Substitution reactions: nucleophilic substitution of alkyl halides- S_N1 and S_N2 mechanisms. Electrophilic substitutions in benzene - reaction mechanism. Addition reactions: electrophilic addition to alkene sand alkynes - Markwonikoff's rule, Peroxide effect. Elimination reactions: E1 and E2 mechanisms.

Unit 3: Stereochemistry of Organic Compounds (9 Hrs)

Stereosiomerism – definition, classification.

Geometrical Isomerism: Definition – Condition – Geometrical isomerism in but-2-ene and but-2-ene-1,4-dioic acid. cis and trans, *E* and *Z* configurations. Methods of distinguishing and interconversion of geometrical isomers.

Optical Isomerism: Optical activity – Chirality – Enantiomers - Meso compounds - Diastereoisomers – Optical isomerism in lactic acid and tartaric acid - Racemisation and resolution (elementary idea only).

Conformations: Newman projection, Saw-horse projection. Conformations of ethane, n-butane, and cyclohexane - Relative stability and energy diagrams. Conformation of methyl cyclohexane.

Unit 4: Natural and Synthetic Polymers (9 Hrs)

Introduction. Classification of polymers: Natural, synthetic; linear, cross-linked and network; plastics, elastomers, fibres; homopolymers and copolymers. Polymerization reactions. Typical examples: Polyethylene, polypropylene, PVC, phenol-formaldehyde and melamine-formaldehyde resins, polyamides (nylons) and polyesters. Natural rubber: structure, latex processing methods, vulcanization and uses. Synthetic rubbers: SBR, nitrile rubber and neoprene. Biodegradability of polymers, environmental hazards. Recycling of plastics.

References

1. I. L. Finar, Organic Chemistry Vol. I , 6th edn. Pearson.
2. M.K. Jain, S.C. Sharma, *Modern Organic Chemistry*, Vishal Publishing Co. 2010.
3. S. M. Mukherji, S. P Singh, R. P Kapoor, Organic Chemistry Vol.1, New Age International Pvt. Ltd, 2006.
4. S. Sengupta, *Basic Stereochemisty of Organic Molecules,* 2014.
5. E. L. Eliel, S.H. Wilen, *Sterechemistry of Organic Compounds,* Wiley, 1994.
6. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th edn. Orient Longman, 1988.
7. S. M. Mukherji, S.P Singh, *Reaction Mechanism in Organic Chemistry*, Macmillan, 3rd edn., 2003.
8. V.R. Gowarikar, N.V. Viswanathan, J. Sreedhar, *Polymer Science*, 2nd edn., New Age International Pvt. Ltd., 2015.

SEMESTER-III

CH3CMT03 - PHYSICAL CHEMISTRY – I

(For students who have opted Physical Sciences and Geology as Main)

Credits-3 (54 Hrs)

Unit 1: Solids and Crystalline State (18 Hrs)

Classification of solids: amorphous, crystalline – differences. Lattice, lattice energy (general idea), unit cell, examples of simple cubic, bcc and fcc lattices, calculation of number of atoms in a unit cell, calculation of lattice parameters of cubic unit cell. Theories of Solid: band theory, conductors, semiconductors and insulators, mention of super conductors. Magnetic Properties: classification - diamagnetic, paramagnetic, antiferromagnetic, ferro and ferrimagnetic, permanent and temporary magnets.

Symmetry of molecules-symmetry elements and symmetry operations – centre of symmetry, plane of symmetry, proper and improper axes of symmetry, crystallographic point groups, Schoenflies symbol. Symmetry elements in crystals - The seven crystal systems – Weiss and Miller indices - Bravais lattices – Bragg's equation (derivation required) and its applications (mention only), structure determination of NaCl by X-ray diffraction.

Unit 2: Liquid State and Solutions (12 Hrs)

Liquids: Intermolecular forces, liquids compared with gases and solids (qualitative idea only), viscosity, surface tension (method of determination not expected), structure of liquids (a qualitative description). Liquid crystals – the intermediate phase between solid and normal liquid phases, thermographic behaviour, classification, structure of nematic and cholesteric phases.

Solutions: Kinds of solutions - Solubility of gases in liquids – Henry's law and its applications - Colligative properties - Osmotic pressure - Reverse osmosis and its applications - Determination of molecular mass using colligative properties.

Unit 3: Gaseous State (9hrs)

Gaseous State: Introduction - Kinetic molecular model of gases – Maxwell distribution of velocities and its use in calculating molecular velocities – Average velocity, RMS velocity and most probable velocity (derivations not required) – Boyle's law – Charles's law – Ideal gas equation – Behaviour of real gases – Deviation from ideal behaviour - Van der Waals equation (derivation not required).

Unit 4: Surface Chemistry and Colloids (9 Hrs)

Adsorption – types of adsorption of gases by solids, factors influencing adsorption, Freundlich adsorption isotherm – Langmuir adsorption isotherm (derivation not required).rue solution, colloidal solution and suspension. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples. Purification of colloids by electrodialysis and ultrafiltration. Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis. Origin of charge and stability of colloids – Zeta potential – Coagulation - Hardy Schulze rule – Protective colloids - Gold number. Emulsions. Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps.

Unit 5: Phase Equilibrium (6Hrs)

The phase rule, definition, equilibrium between phases, one component system – water system, two component systems: solid- liquid equilibrium – simple eutectic, lead-silver system, solid solution. Distribution law, partition coefficient, applications.

References

1. B.R. Puri, L.R. Sharma, M.S. Pathania, *Elements of Physical Chemistry*, 40thedn. Vishal Pub. Co. Jalandhar (2013)
2. B. R. Puri, L.R. Sharma and K.C. kalia, *Principles of Inorganic Chemistry*, Milestone Publishers New Delhi. 2013.
3. J.A. K. Tareen and T.R. N. Kutty, *A basic course in Crystallography*, University Press, 2000.
4. Anthony R West, Solid State Chemistry and its Applications", Wiley Eastern
5. V.Ramakrishnan and M.S.Gopinathan, "Group Theory in Chemistry", Vishal Publishing Co.
6. Gurdeep Raj, "Advanced Physical Chemistry", Goel Publishing House.
7. Walter J. Moore, Physical Chemistry, 4thEdn. Longmans Green and Co. Ltd.
8. P. W Atkins, "Physical Chemistry", Oxford University Press.
9. R. J Silby and R.A Alberty, "Physical Chemistry", John Wiley & Sons.

SEMESTER III

CH3CMT04: INORGANIC AND ORGANIC CHEMISTRY

(For students who have opted Life Sciences and Family & Community Science as core)

Credits - 3 (54 Hrs)

Unit 1: Nuclear Chemistry (12 Hrs)

Nuclear Stability - Mass defect, Binding energy, Nuclear forces, Magic number, Packing fraction, n/p ratio. Natural and induced radioactivity, radioactivity – detection, Units of radioactivity. Modes of decay – Group displacement law. Isotopes, isobars and isotones with examples. Nuclear fission - Atom bomb – Nuclear fusion – Hydrogen bomb - Nuclear reactors - Nuclear reactors in India. Application of radioactive isotopes – ^{14}C dating – Rock dating – Isotopes as tracers – Radio diagnosis and radiotherapy.

Unit 2: Bioinorganic Chemistry (6 Hrs)

Thermodynamics of Living cell- Exergonic and endergonic reactions, coupled reactions. Metal ions in biological systems - Biochemistry of iron – Metalloporphyrins - Haemoglobin and myoglobin, pH of blood, cytochromes, Ferredoxine - Mechanism of O_2 and CO_2 transportation - Chlorophyll and photosynthesis (mechanism not expected) elementary idea of photophosphorylation. Photosynthesis and respiration – comparison. – Elementary idea of structure and mechanism of action of sodium potassium pump. Biochemistry of zinc and cobalt.

Unit 3: Chemistry and Agriculture (12 Hrs)

Fertilizers: NPK, superphosphates, triple super phosphate, uses of mixed fertilizers, micronutrients and their role, bio-fertilizers, plant growth hormones.

Pesticides: Classifications with simple examples, Biopesticides. Insecticides – stomach poisons, contact insecticides, fumigants. Method of preparation and use of DDT, BHC, pyrethrin. Herbicides - structure and function of 2, 4,-D and 2,4,5 –T, Fungicides- inorganic and organic- Bordeaux mixture. Excessive use of pesticides – environmental hazards.

Unit 4: Heterocyclic Compounds (12 Hrs)

Aromaticity – Huckel's rule, preparation (any one method), properties, structure and aromaticity of furan, pyrrole, pyridine and indole. Pyrimidines & purines - adenine, guanine, thymine, cytosine and uracil.

Unit 5: Drugs (6 Hrs)

Classification of drugs. Structure, therapeutic uses and mode of action (synthesis not required) of Antibiotics: Ampicillin, Sulpha drugs: Sulphanilamide, Antipyretics: Paracetamol, Analgesics: Aspirin, Antacids: Ranitidine, Antimalarials: Chloroquine and Anti-cancer drugs: Chlorambucil. Psychotropic drugs: Tranquilizers, antidepressants and stimulants with examples. Drug addiction and abuse. Prevention and treatment.

Unit 6: Food Additives and Cosmetics (6 Hrs)

Food Additives: Food preservatives, artificial sweeteners, flavours, emulsifying agents, antioxidants, leavening agents and flavour enhancers (definition and examples, structures not required) – Structure of BHT, BHA and MSG - Commonly used permitted and non-permitted food colours (structures not required) - Fast foods and junk foods & their health effects – Soft drinks and their health effects.

Cosmetics: Introduction, classification. Dental cosmetics, Shampoos, Hair dyes, Skin products, Shaving cream, Talcum powder, Perfumes and Deodorants (composition and health effects).

References

1. H.J. Arnikar, *Essentials of Nuclear Chemistry* (Revised IV edn.),New Age, 1995.
2. B. R. Puri, L. R. Sharma, M.S. Pathania, *Elements of Physical Chemistry*, 3rd edn. Vishal Pub Co., 2008.
3. I. L. Finar, *Organic Chemistry* Vol. 1 & 2, 6th edn., Pearson, 2002.
4. C.N. R. Rao, *University General Chemistry*, Macmillan 2009.
5. B. R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers New Delhi. 2013.
6. G. R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
7. J.Ghosh, *A Textbook of Pharmaceutical Chemistry*, S. Chand & Co Ltd., 1997
8. B. Sreelakshmi, *Food Science*, New Age International Pvt. Ltd, New Delhi, 2015.
9. J.W. Hill, T.W. McCreary, D.K. Kolb, *Chemistry for Changing Times*, Prentice Hall, 12^{th} edn., 2010.

SEMESTER-IV

CH4CMT05 - PHYSICAL CHEMISTRY – II

(For students who have opted Physical Sciences and Geology as Main)

Credits-3 (54 Hrs)

Unit 1: Introduction to Spectroscopy (9 Hrs)

Interaction of electromagnetic radiation with matter, electromagnetic spectrum, quantization of energy, electronic, vibrational and rotational energy levels, Boltzmann distribution of energy (formula only), population of levels.

UV- Visible Spectroscopy: Beer Lambert's law, molar extinction coefficient and its importance, UV spectrum, max, chromophore, auxochrome, red shift, blue shift, types of transition.

Infra-red spectroscopy: vibrational degrees of freedom, types of vibrations – symmetric and asymmetric stretching and bending, calculation of force constant, concept of group frequencies-frequencies of common functional groups in organic compounds, Fingerprint region in IR spectra.

Rotational Spectroscopy: diatomic molecules, determination of bond length.

Unit 2: Nano Chemistry (9 Hrs)

Terminology- scales of nanosystems- nanoparticles. Nanomaterials – synthesis – chemical precipitation, mechano-chemical method, micro emulsion method, reduction technique, chemical vapour deposition and sol-gel method (brief study).Properties and applications of fullerenes and carbon nanotubes. Nanochemical devices- optoelectronic devices- photodetectors- LEDs and lasers.

Unit 3: Kinetics, Catalysis & Photochemistry (18 Hrs)

Kinetics: Rates of reactions - Factors influencing rate of reactions - Order and molecularity - Zero, first, second and third order reactions - Derivation of integrated rate equations for first order and second order reactions (single reactant only) - Half-life period for first order reaction - Units of rate constants - Influence of temperature on reaction rates - Arrhenius equation - Calculation of Arrhenius parameters - Collision theory of reaction rate, Activated complex theory-basic concepts-no derivation required.

Catalysis: Types of catalysis – Homogeneous and heterogeneous catalysis. Theories of catalysis: Outline of intermediate compound formation theory and adsorption theory.

Laws of photochemistry, Grothus Draper law, Stark-Einsten's Law, Beer Lambert's Law. Photochemical equivalence and quantum explanation for low and high quantum yields. Photosensitization, Jablonski diagram- Fluorescence and phosphorescence, flash photolysis and chemiluminescence.

Unit 4: Electrochemistry (18 Hrs)

Introduction- Faraday's laws of electrolysis, electrochemical equivalent and chemical equivalent, Specific conductance, equivalent conductance and molar conductance – Variation of conductance with dilution - Kohlrausch's law - Degree of ionization of weak electrolytes - Application of conductance measurements –Determination of degree of dissociation of weak electrolytes, conductometric titrations involving strong acid- strong base, strong acid-weak base, weak acid- strong base, and precipitation titration.

Galvanic cells - Cell and electrode potentials - IUPAC sign convention, Types of electrodes: Reference electrodes – Standard hydrogen electrode and calomel electrode, Indicator electrodes-metal-metal ion electrodes, Quinhydron electrode and Redox electrodes. Standard electrode potential - Nernst equation, electro chemical series. Gibb's Helmholtz equation and EMF of a cell.

Fuel cells- H2-O2 fuel cell. Potentiometric titrations of acid-base and redox reactions-precipitation reactions.

References

1. Banwell, C. N. &Mc Cash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
2. D. L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to spectroscopy 3rd edn, Thomson Brooks/Cole, 2001.
3. V. S. Muraleedharan and A. Subramania, *Nanosciece and nanotechnology*, Ane Books Pvt. Ltd. New Delhi, 2009
4. T. Pradeep, *Nano: The Essentials*, McGraw-Hill education, New Delhi,2006.
5. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.
6. B. R. Puri, L.R. Sharma, M. S. Pathania, *Elements of Physical Chemistry*, 40th edn. Vishal Pub. Co. Jalandhar (2003).
7. G. M. Barrow, *Physical Chemistry*, 5th Edition, Tata McGraw Hill Education, New Delhi, 2006.
8. G. K. Vemulapalli, Physical Chemistry, Prentice-Hall of India Pvt. Ltd. (1997)
9. Gurdeep Raj, Photochemistry, 6th Edn, Goel Publishing House, 2014.

SEMESTER IV

CH4CMT06 ADVANCED BIO-ORGANIC CHEMISTRY

(For students who have opted Life Sciences and Family & Community Science as core)

Credits - 3 (54 Hrs)

Unit 1: Natural Products (6 Hrs)

Terpenoids: Classification with examples – Isoprene rule – Isolation of essential oils by steam distillation – Uses of lemongrass oil, eucalyptus oil and sandalwood oil - Source, structure and uses of citral and geraniol.

Alkaloids: Classification – Isolation, general properties. Source, structure and physiological activity of nicotine, coniine and piperine.

Unit 2: Lipids (6 Hrs)

Lipids: Classification – Oils, fats and waxes (definition, structure, biological functions and examples). Hydrogenation and Rancidity - Acid value, Saponification value and Iodine value –. Biological functions of phospholipids and glycolipids

Soaps and Detergents: Soaps – Types of soaps. Cleansing action of soaps. Synthetic detergents - Classification. Comparison between soaps and detergents. Environmental aspects.

Unit 3: Amino Acids and Proteins (12 Hrs)

Amino acids: Classification – Zwitter ion formation and isoelectric point- Synthesis of glycine, alanine, and phenyl alanine (any one method). Peptides: Peptide bond. Synthesis of peptides (upto dipeptides). Proteins: Classification of proteins – Primary, secondary and tertiary structure of proteins -– Denaturation of proteins – Tests for proteins.

Unit 4: Enzymes and Nucleic Acids (9 Hrs)

Enzymes: Nomenclature, classification and characteristics. Mechanism of enzyme action. Theory of enzyme catalysis – Michaelis-Menten theory. Cofactors and coenzymes. Enzyme inhibitors. Uses of enzymes.

Nucleic acids: Structure of pentose sugar, nitrogenous base, nucleoside and nucleotide – Double-helical structure of DNA – Differences between DNA and RNA. Biological Functions – Replication and protein biosynthesis. Transcription and Translation. Genetic code. Energy rich molecules: Elementary structure of ATP, ADP and AMP.

Unit 5: Carbohydrates (12 Hrs)

Carbohydrates: Classification with examples. Preparation and properties of glucose, fructose and sucrose. Cyclic structures and Haworth projections of glucose, fructose, maltose and sucrose (ring size determination not expected). – Mutarotation. Conversion of glucose to fructose and vice versa. – Structure of starch and cellulose (structure elucidation not expected). Industrial applications of cellulose.

Unit 6: Vitamins, Steroids and Hormones (9 Hrs)

Vitamins: Classification. Structure, biological functions and deficiency diseases of vitamins A, B_1, B_2, B_3, B_5, B_6, B_{12} (structure not required), C and D.

Steroids: Introduction. Structure and functions of cholesterol. Elementary idea of HDL and LDL. Bile acids.

Hormones: Introduction. Steroid hormones, peptide hormones and amine hormones (examples, endocrine gland and biological functions, structure not required). Artificial hormones (elementary study only).

References

1. Maya Shankar Singh, L.G.Wade, *Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
2. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
3. I.L. Finar, *Organic Chemistry Vol. I & II*, 5th Edition, Pearson Education, New Delhi, 2013.
4. M.K. Jain, S.C. Sharma, *Modern Organic Chemistry*, Vishal Publishing Co. 2010.
5. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (P) Ltd., New Delhi, 2004.
6. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.
7. A.C. Deb, *Fundamentals of Biochemistry*, 9th Edn. New Central Book Agency,2001.
8. Rastogi, *Biochemistry*, Tata Mc Graw –Hill Publication ,1996.
9. Bhat S.V., Nagasampagi, B.A. & Sivakumar M. *Chemistry of Natural Products*, Narosa, 2005.

PRACTICAL-I

(Semester I and II)
(Common to Physical sciences, Life sciences, Geology and Family & Community sciences)

CH2CMP01 - VOLUMETRIC ANALYSIS

Credit – 2 (72 Hrs)

Standard solution must be prepared by the student.

1. Acidimetry and Alkalimetry

1. Standardization of HCl with standard Na_2CO_3 solution
2. Standardization of NaOH with standard oxalic acid solution
3. Estimation of any acid using standard NaOH
4. Estimation of any alkali using standard HCl.

2. Permanganometry

1. Standardization of $KMnO_4$ using (i) oxalic acid (ii) Mohr's salt
2. Estimation of Fe^{2+} in Mohr's salt and crystalline Ferrous Sulphate using standard $KMnO_4$.

3. Dichrometry

1. Estimation of Ferrous ions (external indicator)
2. Estimation of Ferrous ions (internal indicator)
3. Estimation of $FeSO_4$. 7 H_2O (external indicator)

4. Iodimetry and Iodometry

1. Standardization of Iodine solution
2. Standardization of Sodium thiosulphate
3. Estimation of $KMnO_4$
4. Estimation of Copper

References

1. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry* 8th edn, Brooks/Cole Nelson
2. *Vogel's Textbook of Quantitative Chemical Analysis* 6th edn., Pearson Education. Ltd.
3. G. D. Christian, *Analytical Chemistry*, JohnWiley and Sons
4. R.D Day, A.L. Underwood, *Quantitative Analysis*, 6th Edn., Prentice Hall of India Pvt. Ltd.

PRACTICAL – II
(Semesters III and IV)

CH4CMP02 - PHYSICAL CHEMISTRY PRACTICALS

(For students who have opted Physical Sciences and Geology as Main)

Credit – 2 (72 Hrs)

1. Viscosity-percentage composition of sucrose solution.
2. Determination of Partition coefficient of a non-volatile solute
3. Transition temperature of salt hydrates, eg. Sodium thiosulphate Sodium acetate etc.
4. Critical solution temperature of phenol water system
5. Phase diagram of two component systems

7. Heat of neutralization
8. Determination of equivalent conductance of an electrolyte 9

. Conductometric titration of strong acid Vs. strong base

10. Potentiometric titrations : Fe^{2+} Vs. $Cr_2O_7^{2-}$ and Fe^{2+} Vs. $KMnO_4$
11. Determination of molecular weight by Rast's method. (Using naphthalene, or biphenyl as solvent and acetanilide, p–dichlorobenzene etc.as solute)
12. Kinetics of simple reactions, e.g. Acid hydrolysis of methyl acetate

References

1. W. G. Palmer: 'Experimental physical chemistry', Cambridge University Press.
2. J. B. Yadav: Advanced Practical Physical Chemistry Goel Publishing House.
3. R. C. Das and B. Behra; 'Experiments in Physical Chemistry' , Tata McGraw hill.
4. K. K. Sharma : 'An Introduction of Practical Chemistry': Vikas Publishing House, New Delhi

CH4CMP03 - ORGANIC CHEMISTRY PRACTICALS

(For students who have opted Life Sciences and Family & Community Science as Core)

Credit – 2 (72 Hrs)

1. Tests for elements: Nitrogen, Halogen and Sulphur
2. Determination of physical constants
3. Study of reactions of common functional groups.
4. Qualitative analysis with a view to characterization of functional groups and identification of the following compounds: Naphthalene, anthracene, chlorobenzene, benzyl chloride, p-dichlorobenzene, benzyl alcohol, phenol, o-, m- and p- cresols, α-naphthol, β-naphthol, resorcinol, benzaldehyde, acetophenone, benzophenone: benzoic acid, phthalic acid, cinnamic acid, salicylic acid, ethyl benzoate, methyl salicylate, benzamide, urea, aniline, o-, m- and p- toluidines, dimethyl aniline, nitrobenzene, o-nitrotoluene, m-dinitrobenzene and glucose. (minimum of ten compounds to be analysed).
5. Organic preparation involving halogenation, nitration, oxidation, reduction, acetylation, benozylation, hydrolysis, diazotization.
6. Isolation of an organic compound from a natural source.

References:

1. A. I Vogel, *A Text Book of Practical Organic Chemistry*, Longman.
2. F. G. Mann and B.C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education.
3. V. K. Ahluwalia and S. Dhingra, *Comprehensive Practical Organic Chemistry*, Universities Press.

N. B: These complementary courses are applicable to relevant Model-II and other course